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THE PHYSIOGRAPHIC ECOLOGY OF CHICAGO AND VICINITY; A STUDY OF THE ORIGIN, DEVELOPMENT, AND CLASSIFICATION OF PLANT SOCIETIES.

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY. XXIV.

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(WITH THIRTY-FIVE FIGURES.)

I. The content and scope of physiographic ecology.

WITHIN the last few years the subject of ecology has come to find a place of more or less importance wherever botany is studied in its general aspects. The limits of the subject, however, have not yet been defined, nor have many attempts been made to bring order out of the chaos which exists with regard to the arrangement of the subject-matter. The main purpose of the present paper is to suggest a classification of a portion of the ecological field.

Whatever its limits may be, ecology is essentially a study of origins and life histories, having two well-marked phases; one phase is concerned with the origin and development of plant structures, the other with the origin and development of plant societies or formations. The plant structure side again has two aspects, one viewing organs or plant forms as a whole, the other viewing the tissues which make up the organs; the former might

be called organographic ecology or even organography, while the latter may be called ecological anatomy.

It may be well to speak more in detail concerning the distributional phase of ecology. There are two distinct aspects here also, the one local, the other regional. Climatic factors, particularly temperature and atmospheric moisture, permit the subdivision of the earth into great zones or regions with characteristic plant formations which extend over wide areas. Examples of this type are tropical evergreen forests, deserts in continental interiors, prairies, deciduous forests, arctic tundras. These formations are widespread because the factors that produce them are widespread. We might call these formations climatic formations (following Schimper[1]) and the subject that deals with them geographic ecology or ecological plant geography. In contrast with the above there are the local or edaphic factors, such as soil (including its moisture, air, and temperature relations), slope, light; in other words, factors that are largely due to the physiographic nature of the district. Where the climate is the same these factors produce marked changes locally, and there results a variety of plant societies, such as swamp, dune, bottom forest, river bluff, etc. These correspond to Schimper's[1] edaphic formations or Warming's plant societies, and the subject that deals with them may be called physiographic ecology.

In order to justify the terminology here given it will be desirable to trace briefly the history of the study of plant societies and then to depict the intimate relations which exist between the physiography of a region and its flora. Before the appearance of Warming's ecological plant geography[2] there had been no attempt to classify the plant formations of the globe in a systematic manner. Warming introduced the term plant society in place of plant formation, because of the varied use of the latter,

[1] SCHIMPER, A. F. W.: Pflanzengeographie auf physiologischer Grundlage 173–176. Jena, 1898.

[2] WARMING, E.: Plantesamfund. Copenhagen, 1895. German edition, translated by Knoblauch. Berlin, 1896.

and made variations in the water content of the soil a basis of classification. Plant societies were divided into hydrophytes, mesophytes, and xerophytes; further than this, however, little attempt was made by Warming to subdivide the plant societies, except in the case of swamp and dune plants. In these two instances, as will appear later, Warming adopted the order of succession in his method of treatment.

Since Warming's great work appeared, ecologists have in general followed his ideas and have attempted to work them out. Noteworthy contributions have also been made which make a comprehensive view of the subject more possible. Schimper[3] has analyzed in a most thorough manner the conditions which determine the distribution of plants in the large, though he has discussed but briefly the purely local or habitat factors. We owe to him, however, the first clear statement of the distinction between edaphic and climatic factors and formations. The minuter treatment of the edaphic formations did not lie within his field, and he has attempted in no sense to give a classification, except in the case of climatic formations.

Graebner[4,5] has published a classification of some of the German vegetation formations, which has not received the attention it deserves. This classification is based in the main on the chemical and physical characteristics of the soil. The primary divisions are chemical, depending on the richness or poverty of the soil in plant foods. The secondary divisions are based chiefly on soil moisture.

N. H. Nilsson[6] in some preliminary notes on Swedish swamps and their vegetation called attention to the striking difference between hydrophytic and xerophytic swamps, and

[3] *Op. cit.*

[4] GRAEBNER, P.: Gliederung der westpreussischen Vegetationsformationen. Schrift. Naturf. Ges. Danzig **9**: 43–74. 1898. See Bot. Centralb. **75**: 277–279. 1898.

[5] GRAEBNER, P.: Ueber die Bildung natürlichen Vegetationsformationen im norddeutschen Flachlande. Archiv der Brandenburgia **4**: 137–161. 1898. See Bot. Centralb. **77**: 212–214. 1899.

[6] NILSSON N. H.: Einiges über die Biologie der schwedischen Sumpfpflanzen. Bot. Centralb. **76**: 9–14. 1898.

gave expression to the view that differences in food supply may account for the facts observed. Schimper[7] has a somewhat similar view, but explains differences in the vegetation of various swamps more along the line of relative ease or difficulty of absorption in the swampy soils. Both Nilsson and Schimper regard peat bogs as essentially xerophytic.

In this historical sketch mention should be made of the work of Flahault[8,9], who has projected and begun to execute a detailed map of the plant societies of France. Conventional color tones are chosen for the various plant societies, and they are plotted on topographic contour maps. Robert Smith[10,11] had just entered upon a similar work in Scotland when death put a stop to his labors. So far as the author knows, Flahault has not concerned himself particularly as yet with the matter of classification. Alb. Nilsson[12] has recently published some interesting studies of Swedish plant societies, tracing the order of succession of vegetation on cliffs and moors. Still more recently Meigen[13] has published a series of short articles, tracing the order of succession in a number of plant societies. Besides the authors named thus far, Drude[14], MacMillan[15], and Pound and Clements[16] have given excellent treatments of the plant formations in their respective regions.

[7] *Op. cit.* 18.

[8] FLAHAULT, Ch.: Projet de carte botanique forestière et agricole de la France. Bull. Soc. Bot. France **41**: 56–94. 1894. Ann. de Géographie **5**: 449–457. 1896.

[9] FLAHAULT, Ch.: Essai d'une carte botanique et forestière de la France. Ann. de Géographie **6**: 289–312. 1897, etc.

[10] SMITH, ROBERT: On the study of plant associations. Nat. Sci. **14**: 109–120. 1899.

[11] SMITH, ROBERT: Botanical survey of Scotland. I. Edinburgh district. II. North Perthshire district. Scot. Geog. Mag. **16**: 385–416; 441–467. 1900.

[12] NILSSON, ALB.: Några drag ur de svenska växtsamhällenas utvecklingshistoria. Bot. Not. **1899**: 89–101; 123–135.

[13] MEIGEN, FR.: Beobachtungen über Formationsfolge im Kaiserstuhl. Deutsch. Bot. Monatsschrift **18**: 145–147, etc. 1900.

[14] DRUDE, O.: Deutschlands Pflanzengeographie, I. Teil. Stuttgart. 1896.

[15] MACMILLAN, C.: Observations on the distribution of plants along shore at Lake of the Woods. Minn. Bot. Stud. **1**: 949–1023. 1897.

[16] POUND and CLEMENTS: The phytogeography of Nebraska. I. General Survey. Lincoln. 1898.

During 1896 and 1897 the author of this paper, in company with his students, endeavored to classify the vegetation about Chicago in accord with Warming's principles. In 1898 a similar and more careful study of this kind was made in northern Michigan. It was of course found to be possible to classify the plant societies by the amount of water in the soil, but it was found that such a classification put together plant societies radically different in their character, and separated plant societies that were obviously closely related. The best instances of these difficulties were seen in the case of heaths and moors. Not only were heaths and moors found to have closely similar species and vegetative adaptations, but these plant societies were often found grading into each other. In water content these societies were very different, the peat moor or bog being hydrophytic and the heath xerophytic. Thus some factor other than water content is responsible for both. In that same year (1898) Nilsson and Schimper published their views on the causes of the xerophytic character of moor vegetation, as outlined above. Furthermore the vegetation of peat bogs is radically different from that of river swamps which have the same water content.

Further field study but added to the difficulties of the situation, and the need of another classification was keenly felt. It was seen at once that no one factor could take the place of the water content of the soil, since that is obviously the most important of all direct factors in distribution, as Warming so ably shows. An attempt was therefore made to relate the facts of distribution to combinations of factors, with the following results. The classification which is about to follow is based in the main on two ideas, viz., that a classification to be true must be genetic and dynamic. In other words, an attempt is made to group plant societies according to their relationship and their evolution.

The influences which govern the distribution of plants reside in the air or soil (regarding water as soil, for the sake of convenience). The atmospheric influences (light, heat, air) operate over wide areas and have subordinate edaphic importance,

whereas the soil influences (soil heat, soil air, soil water, soil chemistry and physics) are of predominant edaphic importance, though of little account when distribution over wide areas is considered. We may say then that atmospheric or climatic factors determine distribution in the large, while local differences are produced by changes in the edaphic or soil factors.

The soil conditions are chiefly determined by the surface geology and the topography. The original character of the soil, whether rock, sand, clay, or marl, depends upon the geological relations. From the vegetation standpoint the topographic relations are commonly much more important, since they condition the presence or absence of drainage, and hence cause striking variations in air content and humus. Doubtless the characteristic features of peat bog vegetation are due to the absence of drainage and consequent poor aeration and accumulation of organic products. Moreover, in so far as the atmospheric factors have an influence on distribution locally, it is largely due to topographic diversities, such as angle and direction of slope.

Having related the vegetation largely to topography, we must recognize that topography changes, not in a haphazard manner, but according to well-defined laws. The processes of erosion ultimately cause the wearing down of the hills and the filling up of the hollows. These two processes, denudation and deposition, working in harmony produce planation; the inequalities are brought down to a base level. The chief agent in all these activities is water, and no fact is better established than the gradual eating back of the rivers into the land and the wearing away of coast lines; the material thus gathered fills up lakes, forms the alluvium of flood plains, or is taken to the sea. Vegetation plays a part in all these processes, the peat deposits adding greatly to the rapidity with which lakes and swamps are filled, while the plant covering of the hills, on the contrary, greatly retards the erosive processes. Thus the hollows are filled more rapidly than the hills are worn away. As a consequence of all these changes, the slopes and soils must change;

so, too, the plant societies, which are replaced in turn by others that are adapted to the new conditions.

There must be, then, an order of succession of plant societies, just as there is an order of succession of topographic forms in the changing landscape. As the years pass by, one plant society must necessarily be supplanted by another, though the one passes into the other by imperceptible gradations. Here then is a classification both genetic and dynamic, a classification which has a place for all possible ecological factors. It is based on the normal physiographic changes of a region and hence should be called a physiographic classification. One thing more must be recognized, and that is that environmental influences are normally cumulative. A plant society is not a product of present conditions alone, but the past is involved as well. For example, a hydrophytic plant society may be seen growing in a mesophytic soil; the author has seen a mesophytic tamarack swamp which can be explained only in this way. We have in this phenomenon a lagging of effects behind their cumulative causes, just as the climax of the heat in summer comes long after the solstice.

In a classification like this great emphasis is placed on border lines or zones of tension, for here, rather than at the center of the society, one can best interpret the changes that are taking place. Of course the order of succession referred to above is a vertical or historical one. One plant society is said to follow another if it is actually superimposed upon the one preceding. In many cases, if not in most, there is a horizontal order of succession at the present time that resembles the vertical succession of which we now have only the topmost member. Instances of similarity between vertical and horizontal orders of succession are well shown in peat swamps and along shores and flood plains. Along a sandy shore it is only by studying the horizontal succession that one can get any idea of the vertical, since all fossil traces of preceding plant societies have passed away. In peat swamps one can sometimes verify the results of a horizontal zonal study by investigating the fossil remains beneath

We may now outline the main features of a physiographic classification of plant societies. Speaking in the large, the tendency of the erosive processes is to reduce the inequalities of the topography and produce a base level. This base level may not soon be reached, though geological history furnishes instances of extensive base leveling. Crustal movements interfere with the erosive agencies and a mature base level topography may become rejuvenated by a great uplift of the land, or sinking on the other hand may check the rapid action of erosion. Yet even with the crustal movements there go these topographic changes and with them the plant societies must change. Putting the facts of physiography in the terms of ecology, the conditions become more and more mesophytic as the centuries pass. In a young topography, such as the recently glaciated areas of Michigan, Wisconsin, and Minnesota, there is a great variety of topographic conditions and of plant societies. Among these are many hydrophytic lakes and swamps and many xerophytic hills. The hills are being denuded and the swamps and lakes are being filled, so that the hydrophytic and xerophytic areas are becoming more and more restricted, while the mesophytic areas are becoming more and more enlarged. In passing from youth to old age then, a region gradually loses its hydrophytic areas and also its xerophytic areas, though in the latter case there is usually at first an increase in the xerophytic areas which is due to the working back of the young streams into the hills. The latter conditions are well shown in Iowa; in the comparatively recent Wisconsin drift of north-central Iowa the topography is much less diversified and there are fewer xerophytic areas than in the older Iowan drift farther south, which has been greatly dissected by stream erosion. Later, however, the inequalities are removed, and we find great mesophytic flood plain areas, such as are seen along the lower Mississippi.

From what has been stated it will be seen that the ultimate stage of a region is mesophytic. The various plant societies pass in a series of successive types from their original condition to the mesophytic forest, which may be regarded as the climax

or culminating type. These stages may be slow or rapid; some habitats may be mesophytic from the start; undrained lakes and swamps fill up and become mesophytic with great rapidity, whereas granite hills might take many centuries or even geological epochs in being reduced to the mesophytic level. Again the stages may be direct or tortuous; we have already seen how the first consequences of stream erosion may be to make mesophytic areas xerophytic. So, too, in flood plains, the meanderings of the river may cause retrogressions to the hydrophytic condition such as are seen in oxbow lakes, or the river may lower its bed and the mesophytic flood plain become a xerophytic terrace. But through all these changes and counterchanges the great mesophytic tendency is clearly seen; mesophytic areas may be lost here and there but many more are gained, so that the approach to the mesophytic base level is unmistakable. Moreover, the retrogressive phases are relatively ephemeral, while the progressive phases often take long periods of time for their full development, especially in their later stages.

The above phenomena postulate congenial climates and more or less static crustal conditions. It is obvious, however, that erosive processes in a desert region do not result in a mesophytic flora; the same is true of alpine and arctic climates. Again, the climate of all regions is doubtless changing, as it has changed in past ages. So, too, there are crustal movements up and down. In other words the condition of equilibrium is never reached, and when we say that there is an approach to the mesophytic forest, we speak only roughly and approximately. As a matter of fact we have a variable approaching a variable rather than a constant. These conditions do not destroy the validity of a physiographic classification, but rather they require an enlargement of conception. Retrogressive phases, *i. e.*, away from the mesophytic and toward the hydrophytic or xerophytic, must be included, as well as progressive phases away from the hydrophytic or xerophytic and toward the mesophytic. In this way all possible conditions are accounted for. For example, upward crustal movements make hills more xerophytic and swamps more

mesophytic, whereas downward movements make hills more mesophytic and swamps more hydrophytic. Thus in the upward movement of hills and the downward movement of swamps, physiographic processes are more or less neutralized and we may speak of retrogressive tendencies; in the other two cases physiographic processes are accelerated and we have more rapid progress toward the mesophytic climax. If a climate grows colder or more arid, we find retrogressive tendencies toward the xerophytic condition, while in a climate that is getting more moist or more genial the mesophytic tendencies of the erosive processes are accelerated. Furthermore, climatic and crustal changes are commonly so slow in comparison with physiographic changes, that it is usually difficult to decipher their tendencies. We can be far more sure, in other words, with relation to the past and future of a topographic form and its plant societies, so far as erosion is concerned, than we can as to the actual effect that changing climatic and crustal conditions are making.

One other modification of the physiographic theory is necessary, as has been clearly shown by recent field studies. While changes in plant societies are certain to follow changes in topography, it does not necessarily follow that plant societies remain the same if topographic conditions remain unchanged. In other words, changes may take place in plant societies more rapidly than in the topography. A cycle of vegetation may be much shorter than a cycle of erosion. One of the most interesting cases of this is seen in a growing river system. In the ravine stage there may be a rapid change from the xerophytic to the mesophytic plant societies on the slopes. As the valley widens xerophytic conditions appear on the slopes once more. This first and relatively short-lived mesophytic condition may be called a temporary climax, in distinction to the more permanent climax of the base level.

In a study of plant societies such as this, it must be recognized that orders of succession are not the same in various regions. There is probably a close analogy between the various society life histories where climatic conditions are the same, but

it remains true, nevertheless, that each region must be worked out by itself. The general principles that are involved in the dynamics of plant societies, however, ought to be essentially the same everywhere. Some instances will be given which will show the necessity for working out the life history of the plant societies in all regions. While the culminating type throughout the northern states east of the Mississippi river is probably a deciduous mesophytic forest, yet the elements of this forest differ greatly in different localities. In central Michigan the maple, beech, and the evergreen hemlock appear to be the leading character trees of the mesophytic forest. In Indiana and Illinois the hemlock is not one of the dominant trees of this forest. In the Alleghanies of Tennessee a large number of tree species assume a place of almost equal importance in the mesophytic forest. Again, in the Chicago region the tulip tree and buckeye are rare and confined to the flood plain forests, while in Tennessee these trees are found in many other plant societies. In the Chicago region the arbor vitae is confined to undrained swamps and xerophytic cliffs, while in northern Michigan it is found in many other habitats. We may perhaps summarize these data by saying that each species varies in habitat in different regions, and that in general a species can grow in the largest number of plant societies at its center of distribution, since there the climatic conditions favor it most highly. In other regions, especially near its areal limits, it can grow only in those plant societies which resemble most closely in an edaphic way the climatic features at the distribution center. Thus the tulip and buckeye, which flourish best in the mesophytic forest climate of the Alleghanies, are found near Chicago only in the most pronounced of our mesophytic societies, those of the flood plain. Again, the arbor vitae, and with it many conifers and heaths, grow near Chicago only on the cliffs and dunes or in the undrained swamps, since these are the most pronounced of our xerophytic habitats and most closely resemble the xerophytic northern climates.

A few words should be said in the way of indicating the

relationship between this and other classifications. Warming's classification, based on the water relations, at two points agrees with the physiographic theory, viz., in the treatment of swamps and dunes. Each of these is treated from the standpoint of the order of succession as revealed by zonal distribution, though in the case of the dunes this order is not one of decreasing or increasing water content. Alb. Nilsson and Meigen (see above), and for that matter many other authors, have studied various plant societies from the standpoint of their order of succession, but so far as the author is aware no previous attempt has been made to establish a comprehensive theory on this basis. Graebner's classification (see above) has several points in common with the physiographic theory, especially as it relates heaths with moors. In this connection it will be of interest to refer to a paper by J. B. Woodworth[17] which indicates a fertile line of research that is but now being taken up by biologists. He shows how the base-leveling processes must influence the evolution of species, since these processes constantly erect new and destroy old barriers, and hence cause isolation in the one case and intermingling of species in the other. Woodworth gives a number of instances of the influence of base leveling upon animal life, and he refers, although but slightly, to the changes which must take place in the plant life as regions are uplifted or approach base level. It seems surprising that such a great field of study has been neglected until now. C. C. Adams, in a paper as yet unpublished, and C. T. Simpson[18] have recently given special cases of the interrelations between physiographic changes and animal distribution.

The general principles of the physiographic theory have been developed as a result of studies in various sections of the country. Since 1898, when the author first began to work along these physiographic lines, the main thought has been to subject

[17] WOODWORTH, J. B.: The relation between base-leveling and organic evolution. Am. Geol. **14**: 209–235. 1894.

[18] SIMPSON, C. T.: On the evidence of the Unionidae regarding the former course of the Tennessee and other Southern rivers. Science N. S. **12**: 133–136. 1900.

the theory to the most rigid test possible. In connection with a number of students, investigations have been carried on about Chicago, in northern Michigan, in Tennessee, and along the Atlantic coast. In all cases it has been possible to find a general consonance between the facts of distribution and the principles as stated above. The theory has suffered many modifications since its first conception, and doubtless it will suffer more. Indeed, it may be discarded altogether for some other better theory. Nevertheless, publication at this time seems to be justified, and it is hoped that this paper may aid in solving some of the riddles of ecology.

The author especially wishes to mention in this place the work of his student and associate, Mr. H. N. Whitford, who has in preparation a physiographic study of the forests of northern Michigan. The author is likewise especially indebted to another of his students, Mr. W. B. McCallum, who has taken all of the photographs with which this paper is illustrated, with the exception of *figs. 7* and *13*, which were contributed by Professor J. J. Allison, of Joliet. Acknowledgment should also be made of the help given by three excellent papers which deal with the general physiographic and geographic features of the Chicago area. To these works by Leverett,[19] Blatchley,[20] and Salisbury and Alden[21] the author has made constant reference. The author has likewise freely used the work of Higley and Raddin.[22]

In the following pages the various series of the Chicago area are discussed in some detail. Two general groups are made, the inland and the coastal. The inland group is subdivided into three series, river, swamp, and upland. The coastal group is subdivided into two series, lake bluff and dune. The river series

[19] LEVERETT, F.: The Pleistocene features and deposits of the Chicago area. Chicago, 1897.

[20] BLATCHLEY, W. S.: The geology of Lake and Porter counties, Indiana. Reprint from the Twenty-second Annual Report of the Department of Geology and Natural Resources of Indiana. Indianapolis, 1897.

[21] SALISBURY, R. D., and ALDEN, W. C.: The geography of Chicago and its environs. Chicago, 1899.

[22] HIGLEY, W. K., and RADDIN, C. S.: The flora of Cook county, Illinois, and a part of Lake county, Indiana. Chicago, 1891.

is remarkably tortuous, involving constructive and destructive, progressive and retrogressive phases. The treatment begins with an erosion gully; then there follow in order the ravine, both in clay and in rock, the xerophytic bluff, and the mesophytic forest. The depositional phases of the river begin with the appearance of a permanent stream; then follow the various stages of the flood plain culminating in the mesophytic forest. The swamp series begins with the pond, treats next the various types of swamps and ends with a brief discussion of the prairie. In the upland series the various stages of the rock hills and then of the clay hills are taken up in turn, culminating in the mesophytic forest. The coastal group is next discussed, beginning with the lake bluff. Finally, there is a brief treatment of the dune series from the beach on through the embryonic and active dune to the established dune on which there finally appears the mesophytic forest.

II. The plant societies.

A. The inland group.

1. THE RIVER SERIES.

A. *The ravine.*—No topographic forms lend themselves so well to a physiographic sketch of the vegetation as do those that are connected with the life history of a river. Beginning with the ravines, which are deep and narrow, because of the dominance of vertical cutting, we pass to the broader valleys, where lateral cutting becomes more pronounced. From this stage on we have to deal with two phases of river action, the destructive, which is concerned with the life history of the bluff, and the constructive, which has to do with the development of the flood plain.

Wherever there is an elevated stretch of land adjoining a body of water, such as a lake bluff, one is apt to find excellent illustrations of the beginning of a ravine. *Fig. 1* shows an embryonic ravine of a type that may be seen frequently along the clay bluffs between Evanston and Waukegan. A ravine of this type is essentially a desert, so far as plant life is concerned.

The exposure to wind and to alternations of temperature and moisture is excessive. The lack of vegetation, however, is due chiefly to the instability of the soil; this instability is particularly great in the case of clay bluffs such as these, where the seepage of water causes extensive landslide action. No plants can get a foothold in such a place, unless it be a few species that may be able to make their appearance between periods of landslide action; among these plants annuals particularly predominate. The perennials that may be found in such places are almost entirely plants which have slid down the bank. Near the center of *fig. 1* is a clump of shrubs that has slid down in this way. Ravines of a similar type may also be seen at many places inland, and wherever found the poverty of vegetation on the slopes is the most striking character.

As a ravine extends itself inland the conditions outlined above may be always seen about its head, but toward the mouth of the ravine the slopes are less precipitous. Torrents cut down the bed of the ravine until a depth is reached approaching the water level at its mouth. From this time on the slopes become reduced and the ravine widens more than it deepens, by reason of lateral cutting, landslide action, and side gullies. After a time a sufficient stability is reached to permit a considerable growth of vegetation. If the erosion is slight enough to allow a vegetation carpet to develop, a high degree of luxuriance may be attained. In fact ravine conditions are usually extremely favorable for plants, after the initial stages have passed. In a comparatively few years the vegetation leaps as it were by bounds through the herbaceous and shrubby stages into a mesophytic forest, and that, too, a maple forest, the highest type found in our region. Nothing shows so well as this the brief period necessary for a vegetation cycle in a favored situation when compared with an erosion cycle.

Of such interest are the facts just noted that it is worth while to mention some of the characteristic ravine plants. Perhaps the most characteristic trees of the Glencoe ravines are the basswood (*Tilia Americana*) and the sugar maple (*Acer saccharinum*),

though the ash, elm, and other trees are frequent. The most characteristic undershrub is the witch hazel (*Hamamelis Virginiana*). The herbaceous plants are notoriously vernal forms, such as Hepatica, Thalictrum, Trillium, Mitella, Dicentra, Sanguinaria; mosses abound and liverworts are frequent. A ravine with the above vegetation is shown in *fig. 2*. We can explain this flora only by regarding it as having reached a temporary climax. Ravine conditions are more favorable for plants than those that precede or follow. The instability and exposure of the gully have gone; in their place there is protection from wind and exposure. The shade and topography favor the collection and conservation of moisture, and as a result there is a rapid development into a high-grade forest, as outlined above.

Rock ravines are much less common in the Chicago area than are those of clay, since the underlying limestone rarely comes near the surface. Excellent illustrations of stream gorges are to be seen at Lockport, and also in various tributaries of the Illinois river near Starved rock. A striking difference between these rock gorges or cañons and the clay ravines is in the slope of the sides. The physical nature of the rock excludes landslide action, hence the sides are often nearly vertical for a long time. Lateral cutting is also relatively slow as compared with clay. Thus the conditions for vegetation at the outset are much more favorable than in a clay ravine. Rock-bound gorges are very shady and often dripping with moisture, hence liverworts and many mosses find here a habitat even more congenial than in the clay. Among the higher forms are found the most extreme shade plants that we have, such as Impatiens, Pilea, and shade-loving ferns, plants whose leaves are broad and remarkably thin. *Figs. 3* and *4* represent cañons of the above description, whose rocks drip with moisture.

The stages of development pass much more slowly in cañons than in clay ravines, largely because the primitive conditions of shade and moisture remain for a long period of time. Nor do the steep slopes permit the development of a wealth of trees and shrubs, since a secure foothold is not easily found. However,

as the cañon broadens out and the slopes become less steep, shrubs and trees come in, though a typical mesophytic forest is rarely seen. The Starved rock ravines are cut in St. Peters sandstone, those at Lockport in the Niagara limestone, yet the vegetation in the two places is essentially alike; at any rate the resemblances are greater than the differences. Much has been

FIG. 1.—Embryonic ravine in the lake bluff at Glencoe. Entire absence of vegetation on the unstable clay slopes with the exception of shrubs and grasses that have slid down from the top.

written on the physical and chemical influences of rocks upon the vegetation. The facts seen here seem to show that the physiographic stage of a region is more important than either. The flora of a youthful topography in limestone, so far as the author has observed, more closely resembles the flora of a similar stage in sandstone than a young limestone topography resembles an old limestone topography. A limestone ravine resembles a sandstone ravine far more than a limestone ravine resembles an exposed limestone bluff or a sandstone ravine resembles an

exposed sandstone bluff. We may make the above statements in another form. Rock as such, or even the soil which comes from it, is of less importance in determining vegetation than are the aerial conditions, especially exposure. And it is the stage in the topography which determines the exposure.

All of the preceding statements as to topographic stages,

FIG. 2.—Ravine at Glencoe with a mesophytic forest vegetation on the slopes (temporary climax). Presence of erosive forces indicated by leaning trees. Water in the stream bed only after rains.

whether young or old, refer not to times but to constructional forms. Two ravines, equally youthful from the topographic standpoint, may differ widely as to actual age in years or centuries, since erosion is more rapid in one rock than in another. In our region, however, elements of actual time are not very important, except as between rock and clay, since the limestone is less soluble and the sandstone is more easily eroded than is often the case.

B. *The river bluff.*—As a valley deepens and widens, the

conditions outlined above undergo radical changes. From this point it will be necessary to discuss two phases in the growing river, the bluff phase and the bottom phase. We have left the clay ravine bluffs in a state of temporary climax, clothed with luxuriant mesophytic forest trees and with a rich undergrowth of vernal herbs. More and more the erosive processes are conspicuous laterally, and widening processes prevail over the more primitive deepening. As a result, the exposure to wind, sunlight, and changes of temperature increases; the moisture content of the slopes becomes less and less. The rich mesophytic herbs, including the liverworts and mosses, dry up and die. The humus oxidizes more rapidly, and a xerophytic undergrowth comes in. In place of Hepatica and its associates, we find Antennaria, *Poa compressa*, *Equisetum hyemale*, and other xerophytic herbs; Polytrichum also replaces the mesophytic mosses. The first signs of the new xerophytic flora are seen at the top of the ravine slope; indeed the original xerophytic plants may never have been displaced here by the ravine mesophytes. As the ravine widens, the xerophytic plants creep down the slope, often almost to the water's edge. Some of the young ravines between Evanston and Waukegan show xerophytes at the summits of the slopes. *Fig. 5* shows a

FIG. 3.—Head of a cañon in the St. Peters sandstone at Starved rock. Erosive forces prominent, and vegetation slight on the dripping slopes.

widening ravine at Beverly hills; the vegetation is much less luxuriant than that shown in the young ravine of *fig. 2*.

After a few years have passed, xerophytic shrubs appear on the bluff in place of the witch hazel and its associates. And it is not long until xerophytic or semi-xerophytic thickets prevail,

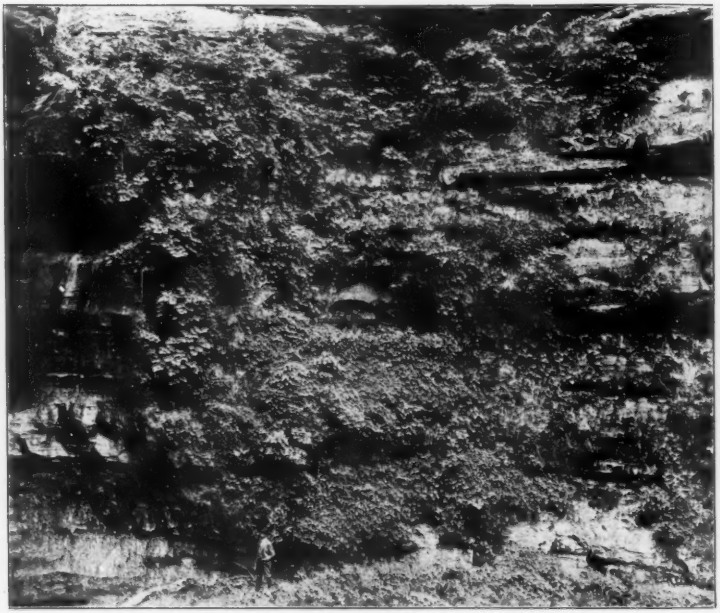

FIG. 4.—Side of a cañon in the St. Peters sandstone at Starved rock. Herbaceous shade vegetation on the precipitous slopes.

in place of the former mesophytic undershrubs. Among the more characteristic of these shrubs are the hop tree (*Ptelea trifoliata*), bittersweet (*Celastrus scandens*), sumachs (*Rhus typhina* and *R. glabra*), choke cherry (*Prunus Virginiana*), nine-bark (*Physocarpus opulifolius*), wild crab (*Pyrus coronaria*). Two small trees are common on stream bluffs, the service berry (*Amelanchier Canadensis*) and the hop hornbeam (*Ostrya Virginica*); this last species is perhaps the chief character tree of river

bluffs and is rarely absent. Perhaps the best examples of xerophytic stream bluffs near Chicago are along Thorn creek. One of the most interesting things about these bluff societies is the frequent presence of basswoods and sugar maples. Doubtless these trees look back to the mesophytic associations that have otherwise disappeared. As would be expected, the last of the

FIG. 5.—Open ravine at Bèverly hills, showing gentle slopes covered with a less mesophytic vegetation than is shown in *fig. 2*. Dominance of oaks in place of maples and basswoods.

mesophytes to die are trees, because they are longer lived than herbs and shrubs, and also because their roots reach down to the moisture. But they cannot be succeeded by their own kind, inasmuch as the critical seedling stages cannot be passed successfully.

The life history of the rock ravines or cañons is somewhat different. When the ravine vegetation is at its height, the moisture and shade are greater here than in the clay, hence the high development of liverworts and their associates. As the ravine

widens these extreme shade forms are doubtless driven out almost immediately by xerophytes, since intermediate or mesophytic conditions are seldom seen where the soil is rock. Furthermore, the xerophytic conditions become much more extreme on rock bluffs than on clay bluffs. This is well illustrated at Starved rock (*fig. 6*), where the dominant tree vegetation is

FIG. 6.—Xerophytic bluff of St. Peters sandstone at Starved rock, on the Illinois river, showing conifers and other plants of dry rocks. Influence of erosive forces seen at the base.

coniferous, consisting especially of the white pine (*Pinus Strobus*) and the arbor vitae (*Thuya occidentalis*). The herbs and undershrubs here are also pronouncedly xerophilous, resembling the vegetation of the sand dunes, *e. g.*, *Selaginella rupestris*, *Campanula rotundifolia*, *Pellaea atropurpurea*, *Talinum teretifolium*, *Opuntia Rafinesquii*, etc. The entire bluff flora down to the river's edge is xerophytic, except in shaded situations.

When a stream in its meanderings ceases to erode at the base of a bluff, increased opportunity is given for plant life. Through

surface wash the slopes become more and more gentle. Mesophytic vegetation comes in at the foot of the bluff and creeps up as the slopes decrease. Finally the xerophytes are driven from their last stronghold, the top of the slope, and the mesophytes have come to stay, at least until the river returns and

FIG. 7.—Ravine in the Niagara limestone at Lockport, showing the beginnings of a flood plain.

enters upon another stage of cliff erosion. The growth of a ravine into a valley with xerophytic bluffs is rapid, when expressed in terms of geology, but far less rapid when expressed in terms of vegetation. A ravine in the vigor of youth may develop so slowly that forest trees may grow to a considerable size without any perceptible change in the erectness of their trunks. Thus in *figs. 2* and *5* it will be seen that most of the trees stand approximately vertical. But the activity of the erosive forces,

slow as it may be, is nevertheless revealed by occasional leaning or even falling trees. From the above it is easy to understand that cycles of vegetation often pass much more rapidly than cycles of erosion, but never more slowly. During one erosion cycle the mesophytic forest develops at least twice, once on the ravine slopes and then finally on the gentler slopes that betoken approach toward base level.

FIG. 8.—General view of the Illinois valley near Starved rock, showing islands and an extensive flood plain with trees along the margin. Young islands in the foreground, older islands in the background.

C. *The flood plain.*—We may now follow the successive stages in the development of the flood plain vegetation. While the ravine is still young, as in *fig. 2*, there is no permanent stream, but merely torrents which remain but a short time. As the ravine deepens, widens, and lengthens, thus approaching the underground water level and increasing the drainage area, the water remains for a longer and longer time after each rainfall. As the ravine conditions thus become more and more hydrophytic, the original flora, perhaps of shade mesophytes (as Impatiens), becomes replaced by amphibious shade plants, such

as the common buttercup (*Ranunculus septentrionalis*), *Plantago cordata*, various mosses, etc. Together with these forms algae of short vegetative period may be found in the wet seasons. When the ravine at last is sufficiently developed to have a permanent stream, a definite hydrophytic flora appears, consisting largely of algae (*e. g.*, Batrachospermum), aquatic mosses, and seed

FIG. 9.—Young island in the Illinois river at Starved rock (close view of island in foreground of *fig. 8*), seen from above, and showing the destructive action of the river.

plants with finely dissected leaves and strong holdfast roots (such as Myriophyllum), though these latter plants are more characteristic of ponds. In the early phases of a stream, the currents are rapid and the vegetation (apart from lower forms) is sparse, by reason of the difficulty which plants have in securing and retaining a foothold on the stream bed. This difficulty is due to the rapid erosion and consequent instability of the substratum, as well as to the direct destructive action of the currents. *Fig. 7* shows one of these young streams, whose flora is sparse.

Springs and spring brooks may be classed with ravine streams, but differ from them in the relative absence of erosion phenomena. This type of stream is uncommon in the Chicago area, though there are a few spring brooks near Chesterton. The water supply is much more constant than in ravine streams, and the shade of the ravines is often lacking. Besides the aquatics there may be mentioned a characteristic brookside flora, including such plants as *Symplocarpus foetidus*, *Asclepias incarnata*, *Chelone glabra*, *Polygonum sagittatum*, and two or more species each of Eupatorium, Lobelia, Mentha, Lycopus, and Bidens. The most characteristic spring brook shrub is the alder (*Alnus incana*), though the extensive northern development of alder thickets has no parallel here.

FIG. 10.—Same island as shown in *fig.* 9, but seen from below, and showing the constructive action of the river. Naked sand bar recently formed at the lower end of the island (left hand), Ambrosia farther toward the right, willows on the older part of the island (extreme right).

As the energy of the developing stream is checked, the conditions for plant life become more favorable. In the quiet pond-like waters of an older stream there may be found many of the aquatics that frequent the ponds and lakes. In fact the flora that is given later as characteristic of half-drained ponds and lakes (such as Calumet lake) may be transferred almost bodily to sluggish streams, such as the Calumet and Desplaines rivers.

When streams are old enough and therefore slow enough to

support a pond vegetation, they have become essentially depositing rather than eroding streams, and we find there the development of a flood plain. While the river is still confined within narrow walls and may thus be called young, there may be embryonic patches of flood plain, representing alternations of erosion and deposition in the stream. *Fig. 7* shows such a con-

FIG. 11.—Flood plain of the Desplaines river at Glendon park, showing encroachment on the river. Willows in the foreground, cottonwoods farther back.

dition of affairs; though the stream is young and more destructive than constructive at that point, there are to be seen small flood plain areas with their typical tree inhabitants.

There is no place where flood plain development can be better studied than on growing islands in relatively rapid and yet essentially depositing streams, such as the Illinois river at Starved rock. *Fig. 8* gives a general view of the Illinois islands and flood plain. In *figs. 9* and *10* the lower island (foreground of *fig. 8*) is seen close at hand. Any obstacle, such as a partially submerged tree trunk, serves to check the river current and cause a deposition of sand or silt, and before long a sand bar

originates. As in the case of a sand dune, the bar itself becomes an obstacle to the currents and hence continually grows larger. The first vegetation, as on the lake beach, consists largely of annuals, especially the giant ragweed (*Ambrosia trifida*); rushes and sedges, some annual and some not, are also present but are less conspicuous. The perennials that manage to survive one

FIG. 12.—Mesophytic flood plain forest in the bottoms of the Desplaines river at Riverside. Elms and basswoods. Rich herbaceous vegetation, consisting largely of Phlox.

season are largely washed away in the winter and spring, so that in reality the vegetation is almost exclusively annual. The first woody plants to get a more or less permanent foothold here are willows (*Salix nigra* and *S. longifolia*).

While islands of the above type gain more soil than they lose, a comparison of *figs. 9* and *10* shows that the river erodes above and deposits below. As a consequence these islands migrate down the river, as well as grow in area year by year.

Hence the upper part of the island is the oldest, as the vegetation well shows. *Figs. 8* and *10* show at the lower end the sand bar, which comes to a point and is so young or so exposed to submergence as to be barren of vegetation. Next comes the Ambrosia, then the willows, and finally a characteristic flood plain

FIG. 13.—Flood plain forest along Fraction run at Lockport, showing a rather striking collection of southern trees (see text). Coffee tree in the foreground.

forest (background of *fig. 8*). The asymmetry of the river island vegetation is in striking contrast with the zonal symmetry of pond islands, as will be shown later (*fig. 19*). The cause is evident, viz., the relative lack of symmetry in river currents as compared with pond currents.

The gradual encroachment of the land upon a stream through continuous deposition is well shown along the Desplaines river, and to a less complete degree along the Chicago river and Thorn

creek. In the Desplaines bottoms the sand bar and island formations of the Illinois are largely absent, the currents being much less rapid. In the shallow water near the margin of the river are various hydrophytes, such as Sagittaria, *Rumex verticillatus*, etc. The outermost fringe of land at ordinary low water is often almost as barren of vegetation as are the islands, but the

FIG. 14.—Flood plain of the Calumet river near Chesterton, showing the beginnings of terrace formation, indicated more by the falling elm than by the topography.

soil is fine and hence makes a mud flat instead of a sand bar. Immediately after the spring freshets have gone, an alga vegetation is frequently found on these flats, consisting especially of Botrydium and Vaucheria. Later in the season annuals, or even scattered perennials, may occur here, though the winter and spring floods uproot or bury most of this vegetation. The Ambrosia and willow vegetation soon appear as described above. The river maple (*Acer dasycarpum*) usually appears with or soon after the willows. After the willows the cottonwood (*Populus monilifera*) and the ash (*Fraxinus Americana*) soon come in. *Fig. 11* shows an advancing flood plain of this type; willows are seen on the margin and cottonwoods farther back.

Gradually the growing flood plain becomes dry enough to permit the germination and development of a true mesophytic flora. The trees named above, especially the willows, are largely replaced by others that seem better adapted to the changed conditions; among these are the elms (*Ulmus Americana* and *U. fulva*), the basswood (*Tilia Americana*), the walnut and

FIG. 15.—Terrace in the flood plain of the Desplaines river at Glendon park showing how a mesophytic flood plain may become xerophytic. The opposite bank shows deposition and flood plain enlargement (*fig. 11*).

butternut (*Juglans nigra* and *J. cinerea*), the pig-nut (*Carya porcina*). In this rich flood plain forest there are many lianas climbing over the trees, *e. g.*, greenbrier (*Smilax hispida*), grape (*Vitis* spp.), Virginia creeper (*Ampelopsis quinquefolia*), and poison ivy (*Rhus Toxicodendron*).

The undergrowth in these river woods is very dense and luxuriant, the alluvial character of the soil making it very fertile. Among the shrubs are the thorns (various species of Crataegus), the gooseberry (*Ribes Cynosbati*), and many others. The herbaceous vegetation is dominantly vernal, the shade being too dense for a typical estival flora. Prominent among the spring

flowering herbs are *Trillium recurvatum*, *Phlox divaricata*, *Polemonium reptans*, *Hydrophyllum Virginicum*, *Mertensia Virginica*, *Collinsia verna*, *Claytonia Virginica*, *Erythronium albidum*, *Arisaema triphyllum* and *A. Dracontium*, *Nepeta Glechoma*, *Isopyrum biternatum*, *Caulophyllum thalictroides*, *Viola cucullata*, *Galium Aparine*. Other characteristic herbs are the nettles (*Urtica gracilis*, *Laportea Canadensis*), various umbellifers (Heracleum, Cryptotaenia, Sanicula, Osmorrhiza), and the parasitic dodder (*Cuscuta Gronovii*). *Fig. 12* shows a characteristic mesophytic flood plain forest along the Desplaines river; underneath the elms and basswoods is seen a rich herbaceous flora, consisting largely of Phlox, which the picture shows in full bloom.

FIG. 16.—An oxbow lake in the flood plain of Thorn creek. The willows are subsequent, dating back to a stream margin, while the shrub (Cephalanthus) and herb vegetation is associated with the present undrained condition.

In some of the bottom lands there is a rather striking collection of trees, whose chief range is mainly southward. *Fig. 13* shows a flood plain tree group near Lockport, most of whose members are largely southern, viz., the coffee tree (*Gymnocladus*

Canadensis), seen in the foreground, the papaw (*Asimina triloba*), the sycamore (*Platanus occidentalis*), and the hackberry (*Celtis occidentalis*). In other flood plains there may be found the mulberry (*Morus rubra*), the red bud (*Cercis Canadensis*), the buckeye (*Aesculus glabra*), and the tulip (*Liriodendron Tulipifera*). None of these trees are common in our district, and only Celtis

FIG. 17.—A dead oxbow lake in the flood plain of Thorn creek. A willow still remains at the right, while the shrubs (Cephalanthus) have closed in upon the lake.

may be regarded as frequent. These relatively southern trees are found not only along the Desplaines and its tributaries, where there is supplied a continuous habitat along the river southward, but also along the Calumet and its tributary, Thorn creek. The occurrence of the tulip tree is full of interest, since it has been found thus far chiefly (perhaps only) in the vicinity of the dunes. Its occurrence has been noted especially at Chesterton along a small stream which empties into Lake Michigan at that point; the tulip tree has also been found away from present streams, but apparently in old valleys whose streams have been diverted by dune activity. The confinement of these southern

trees to flood plains is not strange, since in such habitats are given the most congenial conditions that can be found in our area.

The vegetation on flood plains is not always as described above. Sometimes meadows are found instead of forests; this condition is particularly well shown along Thorn creek. *Fig. 18* shows a stretch of meadow of this type. Besides various grasses

FIG. 18.—Flood plain of Thorn creek near Glenwood, showing a meadow instead of a forest. At the center is an uneroded island, detached from the morainic mainland, seen at the left. The vegetation of the island is similar to that of the morainic uplands.

(such as *Poa pratensis* and *Agrostis alba vulgaris*), there are often other plants in abundance, *e. g. Thalictrum purpurascens*, *Fragaria Virginiana*, *Anemone Pennsylvanica*. The ecological meaning of the meadow is not clear. Probably mowing or grazing is responsible for the failure of a mesophytic forest to develop. Extensive thorn (Crataegus) thickets sometimes occur in these meadows and probably betoken the beginning of a mesophytic forest. Extensive and apparently natural meadows are found in the Calumet valley.

As we have seen, the climax type of vegetation on the flood

plain is the mesophytic forest, but here, as well as on the river bluffs, the climax may be but temporary. Retrogression is almost sure to come in connection with terrace formation. While it is true that deposition is the main feature of flood plains, it is also true that erosion has not ceased; the downward cutting of the river once more causes vertical banks, though this time in its own flood plain. This action is seen in *fig. 14* which shows the beginning of the new erosive phase, and its indication in the falling elm. There has doubtless been lateral erosion here also, since elms are not usually marginal trees. *Fig. 15* shows the erosion of the flood plain still farther advanced; this bank is just opposite the willow vegetation shown in *fig. 11*, hence there is deposition on one side and cutting on the other. A river may thus swing quite across its flood plain, destroying all that it has built, including the mesophytic forest. Not only is the vegetation destroyed directly, as shown in *fig. 14*, but also indirectly, since the lowering of the river causes the banks to become more xerophytic. In place of the herbaceous mesophytes, Equisetum and other relatively xerophytic forms may appear, though the trees usually live until directly overthrown by the river.

One more phase of river activity may be briefly sketched. In meandering over a flood plain, serpentine curves or oxbows are frequently formed. In time the river breaks across the peninsula and the oxbow remains as a crescentic lake. The conditions radically change almost immediately, and the river life is replaced by pond life. The change is even more striking on the margins, where the old plants pass away and the forms of undrained swamps come in. *Fig. 16* shows the remnant of one of these oxbows; on the farther side are old and dying willows, trees that look back to the well drained river margin. On either side of the pond are seen clumps of the button bush (*Cephalanthus occidentalis*), one of the most characteristic plants of undrained swamps. Thus the willows are antecedent and the button bush subsequent to the formation of the cut-off. *Fig. 17* shows a portion of the same, in which the willows and even the pond itself have gone, and only the marginal button bush is left,

though in this case, the margin occupies the center of the original pond. Near Starved rock an extinct oxbow lake on the flood plain of the Illinois river contains an extensive patch of Sphagnum and Osmunda, among the most characteristic plants of undrained swamps. There are many undrained swamps, some with tamaracks, in the Calumet valley. The future of these swamps is like that of other swamps, and will be described in the next section. *Fig. 18* shows a morainic island in the Thorn creek flood plain; the stream has meandered but has thus far left this detached fragment of the morainic mainland with a large part of its original flora.

In closing the section on rivers, all that is needed is to emphasize again the idea that the life history of a river shows retrogression at many points, but that the progressions outnumber the retrogressions. Not only this, but retrogressive phases are relatively ephemeral. Thus a river system, viewed as a whole, is progressive, and through all its vicissitudes there is an ever increasing area of mesophytic forest. When the theoretical base level is reached there seems to be no apparent reason why mesophytic forests should not be developed throughout most of the great plain.

[*To be concluded.*]

UNDESCRIBED PLANTS FROM GUATEMALA AND OTHER CENTRAL AMERICAN REPUBLICS. XXII.[1]

JOHN DONNELL SMITH.

(WITH PLATE 1)

Xylosma Turrialbanum Donn. Sm.—Folia magna oblongo-elliptica longe obtuseque acuminata in basin obtusiusculam aut retusam angustata membranacea integerrima glabra minute pellucido-punctata, venis venulisque transversis subparallelis. Florum masculinorum pedicelli fasciculato-congesti floribus 4–5-plo longiores ad tres partes longitudinis articulati. Sepala 5. Stamina 15 sepalis paulo breviora. Discus subinteger, glandulis nullis.

Ramis spiniformibus 1–7^{cm} longis armatum, his florum fasciculis saepe ornatis. Folia 9–13^{cm} longa 3–5^{cm} lata pellucida basi nonnunquam minute bilobata, nervis lateralibus utrinque 6–8 subtus prominulis, petiolis 5–10^{mm} longis. Pedicelli indefiniti 9–11^{mm} longi pubescentes, bracteis pilosis, bracteolis rudimentariis. Sepala oblongo-ovata 3^{mm} longa parce pubescentia. Filamenta 2^{mm} longa infra medium pubescentia, antheris elliptico-globosis dorso affixis. Discus annularis carnosus 2^{mm} diametralis ciliolatus ceterum glaber. Flores feminini fructusque ignoti.—Inter species Americanas foliis integerrimis insigne.

In fundo Aragon vocato in declivibus Turrialbanis sito, Costa Rica, alt. 630^{m}, Jan. 1899, *Pittier*, no. 7518 Pl. Guat. &c., qu. ed. Donn. Sm. (n. 13217 herb. nat. Cost,).

Monnina saprogena Donn. Sm. (§ HEBEANDRA Chodat, Bull. Herb. Boiss. **4**: 243.)—Folia estipulata crassiuscula glabra lanceolata-elliptica acuminata in petiolum attenuata, nervis lateralibus utrinque 3–4 erecto-patentibus distinctis ante marginem evanidis supra subimmersis, venis obsoletis. Racemi paniculati, floribus pedicellos paulo superantibus. Sepala interiora per duas partes connata. Carina subintegra. Discus conspicue unilateralis, ovario dimidiato-elliptico glabro uniloculari. Fructus

[1] Continued from BOT. GAZ., **27**: 443. 1899.

inaequilateralis oblongo-ovatus acutiusculus bicarinatus et bicostatus indistincte areolatus.

Arbuscula (Tonduz in schedula), caulibus teretibus glabris. Folia 6–9^{cm} longa 2–3^{cm} lata, petiolis 6–7^{mm} longis. Paniculae terminales et subterminales puberulae laxiflorae 10–16^{cm} longae, bracteis ovatis 4^{mm} longis ciliatis cito deciduis, pedicellis 3–4^{mm} longis, floribus 6^{mm} longis. Sepala pubescentia ciliataque, exteriora inferiora ovalia, superius majus ovatum 2.5^{mm} longum, alae orbiculares 5^{mm} diametrales extus pube punctatae e basi distincte nervosae. Carina ad apicem biplicata, petalis interioribus intus cum vagina staminea cano-pilosis, limbo lingulato 3^{mm} longo. Stylus complanatus ovario bis longior. Fructus glaber sublaevis 6^{mm} longus 2.5^{mm} latus, disco gibboso glanduliformi.

In truncis putridis, La Palma, Costa Rica, alt. 1542^{m}, Aug. 1898, *Tonduz*, no. 7406 Pl. Guat. &c. qu. ed. Donn. Sm. (n. 12501 herb. nat. Cost.).

MYRODIA GUATEMALTECA Donn. Sm., BOT. GAZ. **16**: 2. 1891.— Hujus speciei e floribus nondum plane evolutis descriptae specimina typica cum *Quararibea Guyanensi* Aubl. satis congruunt. Ejusdem plantae exempla Guatemalensia nuper a Barone de Tuerckheim transmissa et flores evolutos et fructus praebent.

Heliocarpus Donnellsmithii Rose. — Mature leaves nearly orbicular, not lobed, rounded at base, shortly acuminate (tips mostly broken), glabrous and shining above, nearly glabrous below, 3 to 5-palmately veined from the base, somewhat glandular-toothed especially at base; inflorescence a large spreading panicle; sepals not appendaged; stipe slender, 5^{mm} long; body of fruit oblong, 5^{mm} long, somewhat hairy, becoming glabrate and rugose in age.

Near Arenal, Department Alta Verapaz, Guatemala, alt. 1500^{m}, April, 1889, *John Donnell Smith*, n. 1722 (type); Coatzacoalcos, Isthmus of Tehauntepec, State of Vera Cruz, Mexico, 1895, *Charles L. Smith*, n. 1002.

This species is very different from the numerous Mexican species, and is near *H. Americanus Schumanni* Baker, but has more glabrous leaves and an absence of hairs both on leaves and inflorescence. Mr. Baker's variety seems to me to deserve specific rank.

EXPLANATION OF PLATE I.— Branch two thirds natural size; fruit × 3.

Villaresia Costaricensis Donn. Sm.— Folia oblongo-elliptica utrinque praesertim apice acuminata submembranacea diaphana

HELIOCARPUS DONNELLSMITHII Rose, n.sp.

pellucido-punctulata integra, costa cum nervis lateralibus utrinque 4–5 venisque subtus conspicua. Racemi extra-axillares terminalesque foliis breviores spiciformes, glomerulis subsessilibus inferne dissitis. Sepala ovata pilosa. Petala glabra oblongo-elliptica sepalis vix bis longiora. Stamina petala paene aequantia. Ovarium pilosum ovoideum 1-loculare. Drupa magna olivaeformis.

Ramuli petiolique recentiores puberuli. Folia glaberrima aetate provectiore subcoriacea 9–12.5^{cm} longa 4.5–5^{cm} lata, petiolis crassis canaliculatis 5–7^{mm} longis. Racemi pubescentes singuli, floriferi 3–5^{cm} longi, fructiferi incrassati usque ad 8^{cm} longi, floribus 3–8 in pedicello crasso 1–2^{mm} longo sessilibus. Sepala 1.5^{mm} longa. Petala quincuncialia apice cuspidata inflexo-valvata 2.5^{mm} longa. Stamina glabra, antheris cordato-ovalibus 1^{mm} longis. Ovarium biovulatum cum stylo brevissimo glabro adjecto petala paene aequans, stigmate obliquo nudo. Drupa pedicello vix ullo insidens 2.5^{cm} longa 1.5^{cm} lata atque crassa apiculata in sicco nigrescens et reticulata, semisepto 5^{mm} lato, seminis testa pallida et atro-venosa.— Genus in America cis circulum aequinoctialem adhuc non obvium.

In silvis prope Copey, Prov. Cartago, Costa Rica, alt. 1800^{m}, Febr. et Mart. 1898, *Tonduz*, nn. 11664, 11995, 11791 herb. nat. Cost.

Blakea tuberculata Donn. Sm. (§ EUBLAKEA Triana.)— Rami crassi teretes cum petiolis pedunculis bracteis et foliorum tergo ferrugineo-furfuracei et -strigillosi. Folia ovato-orbicularia abrupte caudato-acuminata basi rotundata supra glabra. Flores fasciculati brevissime pedunculati inter maximos. Bracteae exteriores usque ad mediam connatae calycis tubum paulo superantes, interiores breviores omnino connatae. Calycis limbus ovali-cylindricus tubum aequans intus coloratus et tuberculatus, lobi retroflexi limbo bis longiores. Petala utrinque tuberculata cum staminibus basi limbi inserta. Genitalia limbo inclusa.

Folia uniuscujusque paris aequalia 13–21^{cm} longa 10–15^{cm} lata coriacea praetermisso utroque nervulo marginali trinervia, nervis in caudam oblongam 9^{mm} longam excurrentibus, venis transversis 3–4^{mm} inter se distantibus, petiolis robustis 4–6^{cm} longis. Pedunculi 3–6-fasciculati crassi 6–10^{mm} longi. Flores diametro 6.5^{cm}, bracteis crassis opacis, exterioribus late orbicularibus 2^{cm} longis uninerviis siccitate retroflexis et margine involutis, interioribus 1.5^{cm} longis margine crispato-plicatis. Calycis tubus campanulatus glaber, limbus 1^{cm} altus 12^{mm} latus carnosulus extus strigillosus in alabastro petala usque ad

duas partes includens, lobi oblongo-ovati herbacei nervosi supra furfuracei subtus strigillosi jam ante anthesin e basi arcte retroflexi. Petala glabra oblongo-obovata 2.5–3^{cm} longa late unguiculata carnosula rosea. Stamina in sicco rubescentia, antheris pendulis dolabriformibus acute calcaratis 8^{mm} longis filamenta subaequantibus. Ovarium diametro 9^{mm}, centro in rostrum oblongo-conicum 5^{mm} longum apice denticulatum producto, stylo gracili 1^{cm} longo, stigmate punctiformi. Baccae non suppetunt.— *B. grandiflorae* Hemsl. proxima.

Limbus propter exsiccationis pressionem diruptus limbum in herbario 6-fissum lobis appendiculatum simulat.

Ad pascuorum margines prope La Palma, Prov. San José, Costa Rica, alt. 1550^{m}, Aug. 1898, *Tonduz*, n. 7363 Pl. Guat., &c., qu. ed. Donn. Sm. (n. 12435 herb. nat. Cost.)

Anguria ovata Donn. Sm.—Tota glaberrima. Folia omnia simplicia integra membranacea concoloria ovata cuspidato-acuminata dimidio longiora quam latiora ad basin rotundam leviter retusa, nervis basilaribus 5, lateralibus utrinque 3. Flores masculini pauci subcapitati. Calyx lineari-cylindricus. Petala utrinque dense furfuracea. Antherae rectae lineares, appendice glabra.

Caulis gracilis striatus. Folia 8.5–9^{cm} longa viridia, venulis reticulatis diaphanis, petiolis 3–5^{cm} longis. Cirrhi tenues striati. Pedunculi masculini striati 12–15^{cm} longi apice brevissime racemosi et 8–12-flori, pedicellis 1–2^{mm} longis. Calyx basi rotundus apice haud constrictus 14^{mm} longus 3^{mm} latus, dentibus obtuse ovatis 1^{mm} longis. Petala suborbicularia 6^{mm} longa 4–5^{mm} lata exunguiculata enervia lateritia. Antherae 10^{mm} longae 1.5^{mm} latae, appendice 0.5^{mm} longa. Flores feminini fructusque desunt.— *A. longipedunculatae* Cogn. proxima.

In dumetis ad Las Vueltas, Tucurrique, Costa Rica, alt. 635^{m}, Feb. 1899, *Tonduz*, n. 13006 herb. nat. Cost.

Gurania Tonduziana Donn. Sm. (§F. 1. Cogn. in DC. Monogr. Phan. **3**: 694.)— Folia circumscriptione cordiformia paulo longiora quam latiora 5-nervia profundissime 7-partita, segmentis 5 interioribus oblanceolato-linearibus, exteriore utroque oblongo et aurito. Pedunculi masculini foliis superati, floribus brevissime spicatis. Calycis pubescentis segmenta linearia tubo 2–3-plo longiora. Antherae oblongae, appendice minuta deltoidea.

Caulis robustus striatus cum petiolis cirrhis pedunculis pubescens. Folia 24^{cm} longa, pagina superiore scabriuscula, inferiore pallidiore pubescente conspicue reticulato-nervosa, margine subundulata remote minuteque spinuloso-denticulata, nervo basilari utroque exteriore imum sinum marginante, segmentis acuminatis, terminali 21^{cm} longo ultra medium 5^{cm} lato basi 13^{mm} lato ceteris interioribus paulo majore, utroque exteriore inequilaterali 6.5^{cm} longo 3^{cm} lato, sinibus inter segmenta rotundis a sinu basilari 2–3^{cm} distantibus, hoc sub-rectangulari 3^{cm} profundo 5^{cm} lato. Pedunculi 17^{cm} longi, spica 8^{mm} longa. Calycis tubûs ovalis 1^{cm} longus 6^{mm} latus, segmenta parce pubescentia 22–25^{mm} longa basi 1^{mm} lata enervia miniata. Petala conniventia lineari-lanceolata 9–10^{mm} longa 2^{mm} lata enervia extus dense glandulari-papillosa intus furfuracea. Antherae 7^{mm} longae 2^{mm} latae tertia parte replicatae, connectivo loculis angustiore, appendice vix 0.5^{mm} longa. Flores feminini fructusque ignoti.—Ad *G. Makoyanam* Cogn. florum indole accedens foliis insigniter recedit.

In sylvis ad Shirores, Talamanca, Costa Rica, alt. 100^{m}, Feb. 1895, *Tonduz*, n. 9332 herb. nat. Cost.

Sciadophyllum systylum Donn. Sm.— Ferrugineo-pubescens. Foliola 7–9 elongato-oblonga longe acutissimeque caudato-acuminata basi obtusa subcoriacea praeter costam tandem glabrescentia, nervis patulis. Umbellae in racemum simplicem cylindricum dispositae. Styli in columnam quam bacca tertia parte breviorem omnino coaliti, stigmatibus 5–6, seminibus abortu paucioribus.

Totum pube detergibili stellata interdum tomentulosa vestitum. Stipulae coriaceae lineares 5–7.5^{cm} longae. Petiolus teres 16–27^{cm} longus, petiolulis canaliculatis, foliolo intimo maximo 14–25^{cm} longo 4–7^{cm} lato, cauda 2.5–3.5^{cm} longa, petiolulo 4–7^{cm} longo, foliolis lateralibus cum petiolulis sensim decrescentibus, infimo utroque 6–14.5^{cm} longo, petiolulo 2–2.5^{cm} longo, nervis lateralibus utrinque 12–18 prope marginem arcuate conjunctis. Racemi 20–35^{cm} longi, ramis satis approximatis 1.5–4.5^{cm} longis, pedicellis circa 10 et 5–8^{mm} longis. Baccae ovali-globosae 3–4^{mm} longae 5–6-angulares, juniores pube stellata punctatae, stylis 2–2.5^{mm} longis, stigmatibus vix 0.5^{mm} longis radiantibus, seminibus 3^{mm} longis, 1–3 saepius abortivis. Flores ignoti.—Species stylis longis totis coalitis insignis.

In sylvis ad El Alto de La Palma, Costa Rica, alt. 1542^{m}, Aug. 1898, *Tonduz*, n. 7395 Pl. Guat. &c., qu. ed. Donn. Sm. (n. 12488 herb. nat. Cost.).

Oreopanax pycnocarpum Donn. Sm.—Stellato-pubescens. Folia simplicia integra crassa pube punctulata mox glabrescentia

nitidaque ovalia utrinque rotundata triplinervia longe petiolata. Capitula fructifera spiciformia oblongo-globosa pedicellis longiora inter maxima in racemos 3-nos abbreviatos pauciramos disposita, baccis compactis stylis liberis 6–7, seminibus abortu saepius paucioribus, albumine aequabili.

Folia 16–20^{cm} longa 8–11^{cm} lata, nervis subangulo angusto ascendentibus, basili utroque exteriore 8^{mm} a basi distante, lateralibus utrinque 3 ultra medium ortis, venis transversis inter marginem et nervum utrumque basilarem subtus conspicuis circa 10, petiolis pubescentibus 10–12^{cm} longis. Racemi pubescentes 7–9^{cm} longi, ramis crassis 8–11^{mm} longis, inferioribus alternis, supremis 4-nis, capitulis 2.5–3.2^{cm} longis 1.8–2.2^{cm} latis, rhachi 1–1.5^{cm} longa, bracteolis cuspidato-ovatis ciliatis. Baccae subglobosae pressione mutua angulatae, nitidae in sicc. pallide flavescentes numerosissimae 8^{mm} longae 6^{mm} latae, stylis stellatim recurvatis 1.5^{mm} longis, seminibus oblongis 3-gonis 5^{mm} longis 2^{mm} crassis. Flores deficiunt.—Ad *O. capitatum* Decne. et Planch. foliis ad *O. macrocephalum* Seem. capitulis accedit.

In sylvis ad Copey, Prov. Cartago, Costa Rica, alt. 1800^{m}, Febr. 1898, *Tonduz*, n. 11933 herb. nat. Cost.

Chomelia microloba Donn. Sm.—Inermis. Folia oblongo-ovata aut-elliptica obtuse acuminata basi acuta aut obtusa coriacea praeter nervorum axillas subtus barbatas glaberrima. Pedunculi terminales bini gracillimi, cymis bifidis multifloris, floribus ebracteolatis. Calyx glaber, ore subintegro. Corollae extus pubescentis tubus infundibuliformis calyce triplo longior, lobis induplicato-valvatis.

Ramuli recentiores cum stipulis cuspidato-triangularibus 3–4^{mm} longis persistentibus et petiolis 4–6^{mm} longis pubescentes. Folia 5.5–10^{cm} longa 3–4.5^{cm} lata, juniora e basi rotunda magis ovata, nervis lateralibus utrinque 4–5. Pedunculi glabri 2.5–3.5^{cm} longi, cymis glabris 3.5^{cm} latis circa 19–25-floris, floribus sessilibus. Calyx cylindricus 3^{mm} longus 1.5^{mm} latus, denticulis vix 0.3^{mm} longis obtusis. Corollae intus glabrae tubus 8–10^{mm} longus, lobi obtuse ovati 3^{mm} longi. Antherae semiexsertae lineares 2^{mm} longae ad tertiam partem longitudinis affixae. Ovarium calycis duas partes aequans, stigmatibus 1^{mm} longis, ovulis linearibus 1^{mm} longis. Drupa in speciminibus suppetentibus deficit.—Ab omnibus congeneribus calyce subtruncato differt.

In sylvis litoralibus ad Santo Domingo de Golfo Dulce, Costa Rica, Febr. 1896, *Tonduz*, n. 7048 Pl. Guat., &c., qu. ed. Donn. Sm. (n. 9874 herb. nat. Cost.

Faramea trinervia K. Sch. et Donn. Sm.—Folia nitida obovato-oblonga vel oblonga contracto-acuminata auriculata subsessilia, nervo utroque basilari percurrente, lateralibus angulo subrecto a costa divergentibus. Cyma foliaceo-bibracteata trichotomo-decomposita, floribus ebracteolatis. Calycis limbus denticulatus discum aequans.

Glaberrima. Folia pergamenea diaphana laete viridia 20–25^{cm} longa medio 6–9.5^{cm} basi 1.5–3^{cm} lata, suprema lineari-oblonga 11^{cm} longa 3^{cm} lata, costa utrinque prominente, nervo a basi utrinque prodeunte conspicuo apicem attingente a margine 5–10^{mm} distante, nervis lateralibus primariis utrinque circa 14, nervum percurrentem attingentibus, petiolis 2–3^{mm} longis. Stipulae 6–8^{mm} longae in vaginam semiconnatae parte libera rotundatae aristatae. Pedunculi singuli ramulos terminantes 4–6.5^{cm} longi apice bracteis ante anthesin caducis instructi. Cyma 4.5–6.5^{cm} alta, ramis late patulis complanatis, iis infimis 4–5.5^{cm} longis, pedicellis accrescentibus 5–11^{mm} longis. Calycis limbus ovarium aequans usque ad medium acute denticulatus. Ovarium post anthesin pedicello paulo crassius cum disco aequilongo truncato adjecto 1.5^{mm} longum. Corolla et fructus desunt.—A ceteris speciebus haec nervatione insigniter differt.

In sylvis ad Boca Zhorquin, Talamanca, Costa Rica, Mart. 1894, *Tonduz*, n. 8571 herb. nat. Cost.; in sylvis Tsakianis, Talamanca, alt. 200^{m}, Apr. 1895, *Tonduz*, n. 9583 herb. nat. Cost.

FARAMEA TRINERVIA **Suerrensis** Donn. Sm.— Folia obovato-vel oblongo-elliptica in caudam gracilem contracta infra medium in petiolum angustata, suprema lanceolata.

Frutex 3–4^{m} altus, ramosus. Foliorum cauda 1.4–2^{cm} longa, petioli 1–1.5^{cm} longi. Bracteae lanceolatae tenuissime elongatae 6^{cm} longae 12^{mm} latae. Florum nondum satis evolutorum pedicelli 2–5^{mm} longi, calycis limbus 1^{mm} altus, dentibus triangularibus, corolla intense cyanea in sicc. nigrescens 6^{mm} longa tubulosa usque ad mediam paene lobata, filamenta longiuscula prope basin corollae inserta, antheris 3^{mm} longis exsertis, ovarium obovatum cum disco conico adjecto 2^{mm} longum. Fructus cyaneus transversim depresso-ovalis 15^{mm} longus 11^{mm} crassus, semine conformi 11^{mm} longo 8^{mm} crasso subtus usque ad medium transversim bipartito, testa pallide scariosa.

In sylvis profundis ad fundum Suerre dictum, Llanuras de Santa Clara, Comarca de Limón, Costa Rica, alt. 300^{m}, Febr. 1896, *Donn. Sm.*, n. 6589, Pl. Guat., &c., qu. ed. Donn. Sm.

Parathesis glabra Donn. Sm.—Omnibus in partibus maculata et praeter corollam glabra. Folia oblongo-elliptica acuminata

in petiolum attenuata integerrima subdiaphana utrinque dense maculata, nervis crebris patulis. Paniculae axillares foliis breviores, pedunculo filiformi, pedicellis ad apicem ramorum primariorum subumbellatis. Calycis segmenta elongato-triangularia. Corollae segmenta linearia. Antherae filamentis bis longiores prope basin affixae per totam longitudinem dehiscentes.

Folia 8–14^{cm} longa 3.5–7^{cm} lata maculis punctata et striatula, nervis inter se 4–6^{mm} distantibus, petiolis canaliculatis 0.8–1.5^{cm} longis. Paniculae cum pedunculo 2.5–4^{cm} longo adjecto 5–7.5^{cm} longae, ramis solitariis 7–15^{mm} longis, pedicellis 3–6-fasiculatis 5–7^{mm} longis, bracteis bracteolisque lanceolato-linearibus parvis, alabastris lanceolato-conicis. Calycis segmenta 1^{mm} longa. Corollae tubus 1^{mm} altus, segmenta e basi 1^{mm} lata attenuata usque ad 7^{mm} longa staminibus bis longiora revoluta intus praesertim marginibus sordide pubescentia. Ovarium conicum calyce brevius parce maculatum, stylo 4.5^{mm} longo. Fructus desideratur.—*Ardisiam ramifloram* Oerst. habitu simulans.

In sylvis ad Copey, Prov. Cartago, Costa Rica, alt. 1800^{m}, Febr. 1898, *Tonduz*, n. 11714 herb. nat. Cost.

MACROSCEPIS CONGESTIFLORA Donn. Sm., BOT. GAZ. **25**: 149. 1898.—Sub hoc nomine eandem plantam atque eodem numero indicatam incaute descripsi, quam typicam *M. pleistanthae l. c.* **20**: 543. 1895, jam ederam.

Markea leucantha Donn. Sm.—Praeter filamenta omnibus in partibus glaberrima. Folia coriacea nitida obovato-oblonga apice rotundata a medio in petiolum attenuata. Flores apice ramorum annotinorum aggregati pauci. Calyx parvus teres coriaceus, lobis oblongo-ovatis brevissime cuspidatis. Corolla calyce 5-plo longior, tubo extra calycem sensim ampliato late infundibulari. Genitalia exserta.

Frutex epiphyticus 2–3^{m} longus verrucosus, ramulis hornotinis quadrangularibus sub apice ramorum plerumque ortis. Folia plerumque geminatim aut ternatim approximatis 7–15^{cm} longa 2.5–5.5^{cm} lata, recentiora magis oblanceolata et acutiuscula, nervis lateralibus utrinque 5–8 subtus tantum conspicuis, petiolis crassis 4–12^{mm} longis. Pedicelli brevissime racemosi in speciminibus suppetentibus 3–8 circa 10^{mm} longi, bracteis subulatis 3^{mm} longis deciduis. Calyx intus nervosus 11–13^{mm} longus usque ad medium fissus. Corolla alba (Cooper in schedula) 5-nervia reticulata 5.3–6.3^{cm} longa, tubo

3.8–4.6^{cm} longo quam faucium latitudo bis longiore, lobis semiorbicularibus. Stamina ad 8^{mm} supra basin corollae inserta 4–4.8^{cm} longa, filamentis ad basin versus incano-barbatis, antheris paulo infra mediam affixis 6^{mm} longis 2.5^{mm} latis. Ovarium ovoideum 4^{mm} altum atque latum, stylo 4.3–5^{mm} longo, stigmatis obconoidei lamellis semiorbicularibus. Bacca desideratur.—Species calyce parvo insignis.

Estrella, Prov. Cartago, Costa Rica, alt. 1800^{m}, Jun. 1887, *Cooper*, n. 5887 Pl. Guat. &c., qu. ed. Donn. Sm.; Prope Juan Viñas, Prov. Cartago, alt. 1140^{m}, Maj. 1890, *Tonduz*, n. 1845 herb. nat. Cost.

Alloplectus macranthus Donn. Sm.—Omnibus in partibus strigilloso-pubescens. Folia maxima oblongo- vel obovato-elliptica apice acuminata in petiolum attenuata et decurrentia inaequilatera subintegra. Pedicelli racemosi bracteis breviores calycem subaequantes, floribus maximis numerosissimis coarctatis. Calycis segmenta breviter connata subaequalia oblonga obtusa integra. Corolla calyce bis longior erecta late infundibularis, limbo obliquo, lobis inaequalibus rotundatis denticulatis.

Caulis pollicis crassitudine in arborum truncis scandens. Folia 23–45^{cm} longa 10–19^{cm} lata, nervis lateralibus utrinque 7–8, petiolis crassis rugosis canaliculatis 4–7^{cm} longis. Racemi aetate provectiore recurvi 2–4^{cm} longi. Bracteae herbaceae ovales aut oblongo-ellipticae 3–4, 5^{cm} longae. Pedicelli 2.5–3^{cm} longi, demum subsecundi. Calyx herbaceus, segmentis circa 2.5^{cm} longis 8–10^{mm} latis. Corolla puberula ex schedula Tuerckheimiana extus candida intus maculato-aurantiaca 6^{cm} longa, tubo 4.2^{cm} longo a basi saccata 6^{mm} lata in fauces 2^{cm} latas sensim ampliato, lobis posticis 1^{cm} anticis 7^{mm} longis. Filamenta in vaginam brevem dilatata, antheris liberis oblongis 6^{mm} longis. Disci glandula solitaria. Ovarium dense pubescens oblongo-ovatum 6^{mm} longum, stylo 1.6^{cm} longo, stigmate concavo. Fructus calyce aucto cinctus ovalis 1.7^{cm} longus 1^{cm} crassus, placentis rubris, seminibus oblongo-ellipticis 1^{mm} longis.—Ab *A. circinnato* Mart. foliis et inflorescentia proximo recedit praecipue corolla infundibulari altero tanto longiore.

In fundo Cubilquitz vocato, Depart. Alta Verapaz, Guatemala, alt. 350^{m}, Jul. 1900, *H. von Tuerckheim*, n. 7642 Pl. Guat. &c., qu. ed. Donn. Sm.—Huic probabiliter referenda sunt specimina a *Tonduz* in Costa Rica lecta et sub n. 13042 distributa. Haec pedicellos densissime aggregatos brevissime racemosos bracteas calycesque erubescentes praebent, corollis tamen carent.

Columnea sulfurea Donn. Sm. (§ EUCOLUMNEA Benth. et Hook.)—Pilis aspersa. Folia disparia subtus vinosa elongato-elliptica utrinque acuminata inaequilatera basi valde obliqua.

Pedunculi solitarii aut bini petiolo longiores calyce breviores. Calycis segmenta vinosa attenuato-linearia tubi corollini duas partes aequantia. Corolla flava infundibulari-tubulosa leviter arcuata, limbo postico quam tubus breviore quam anticus porrectus altero tanto paene longiore, galea truncata. Ovarium dense pilosum.

Epiphytica, caule crasso parum ramoso erubescente, internodiis 1.5–3.5^{cm} longis, superioribus et petiolis pedunculis calycibus densius rubro-pilosis. Folia discoloria utrinque sparsim bulboso-pilosa ad basin latere altero obtusa altero valde exciso acuta, uniuscujusque paris folio florali 7.5–11.5^{cm} longo 2.5–4^{cm} lato, minore conformi 3–4^{cm} longo, petiolis 3–7^{mm} longis. Pedunculi plerumque singuli 9–15^{mm} longi. Calycis segmenta sublibera 2.5^{cm} longa. Corolla ex sched. Tuerckheimiana sulfurea sparsim pilosa 6.8^{cm} longa basi 3^{mm} faucibus 7^{mm} lata, tubo basi gibbo, limbo postico 3^{cm} longo, galea 1.5^{cm} longa atque lata integra, lobis lateralibus angulo recto subtriangularibus 1^{cm} longis obtusis, limbo antico lineari-oblongo 1.5^{cm} longo. Stamina 5.8^{cm} longa, antheris oblongis 3^{mm} longis, staminodio 4^{mm} longo. Disci glandula solitaria crassa bidentata. Ovarium ovoideum 2^{mm} altum, stylo rubro 6.5^{cm} longo ad apicem versus pubescente, stigmate bilamellato. Fructus ignotus.

Cubilquitz, Depart. Alta Verapaz, Guatemala, alt. 350^{m}, Febr. 1900, *H. von Tuerckheim*, n. 7646 Pl. Guat. &c., qu. ed. Donn. Sm.

COLUMNEA MICROCALYX **macrophylla** Donn. Sm.— Folia membranacea pubescentia oblongo-elliptica vix acuminata basi cordata inaequilatera, uniusque paris majus usque ad 5^{cm} longum et 2^{cm} latum, alterum triente minus. Calyx virescens corollae 6.7^{cm} longae quintam partem aequans.

In sylvis prope Las Vueltas, Tucurrique, Costa Rica, alt. 650–700^{m}, Dec. 1898, *Tonduz*, n. 12932 herb. nat. Cost.

Napeanthus repens Donn. Sm.— Herba repens acaulis strigilloso-pubescens. Folia opposita subrosulata petiolata tenuimembranacea oblongo-elliptica utrinque acuminata dentata. Pedicelli fasciculati filiformes. Calycis segmenta sublibera 3-nervia. Corolla rotata, tubo brevissimo, faucibus explanatis, limbo alte fisso subbilabiato. Stamina 4, loculis ovoideis divergentibus distinctis. Ovarium corollae tubum aequans. Capsula membranacea sphaerica.

Folia 4–9^{cm} longa 2–3.5^{cm} lata plerumque inaequilatera supra densius pubescentia subtus pallidiora et purpureo-reticulata, dentibus magnis crebrisque. Pedicelli complures 2–3.5^{cm} longi inferne marginati. Calycis segmenta lineari-lanceolata 2^{mm} longa dense pubescentia exreticulata. Corolla alba parce pubescens diametro circa 1^{cm}, faucibus 3^{mm} latis, segmentis parum aequalibus ovalibus 3–4^{mm} longis. Stamina glabra, filamentis 1^{mm} longis inferne marginatis, antheris reniformibus supra medium affixis reversis 0.5^{mm} latis ante anthesin leviter cohaerentibus, loculis poro laterali subrotundo dehiscentibus. Ovarium pubescens, stylo 3.5^{mm} longo, stigmate parum bifido. Capsula diametro 1.5^{mm} calyce immutato inclusa.

In rupibus praeruptis humidissimis, Cubilquitz, Depart. Alta Verapaz, Guatemala, alt. 350^{m}, Jun. 1900, *von Tuerckheim*, n. 7647 Pl. Guat. &c., qu. ed. Donn. Sm.

Amphilophium oxylophium Donn. Sm.—Pilis singulis dense molliterque ochraceo-tomentosum. Stipulae foliaceae. Folia conjugata cirrho carentia, foliolis breviter petiolulatis ovato-cordiformibus contracto-acuminatis infra indumentum supra tuberculatis subtus lepidotis. Calycis limbus tubum aequans lobos 2 interiores plus quam duplo superans, lobis exterioribus triangularibus induplicatis reflexis. Corolla glabra ultra mediam labiata, labio inferiore fisso. Ovarium lepidotum glabrum.

Caulis cum petiolis thyrsoque robustus et floccoso-tomentosus. Stipulae 10–12^{mm} longae deciduae. Petioli 2–2.5^{cm} petioluli 8–12^{mm} metientes. Foliola 7–12^{cm} longa 5–75^{cm} lata supra pilis simplicibus adpressis vestita subtus pilis ramosis densius tomentosa et pallidiora. Thyrsus contracto-cylindricus in speciminibus suppetentibus vix evolutus 1^{dm} longus, bracteis bracteolisque lineari-lanceolatis 1–1.5^{cm} longis. Calycis totius lepidoti tubus subglobosus 8^{mm} longus dense pilosus, limbus utrinque parce pilosus, lobis 5 exterioribus 5–6^{mm} longis, interioribus lati-rotundatis 3^{mm} longis extus parce pilosis. Corolla 2.5^{cm} longa ad apicem versus minutissime lepidota intus prope insertionem staminum linea lepidota incrassata, tubo 1^{cm} longo, labii inferioris laciniis 13^{mm} longis. Stamina majora 13^{mm} minora 10^{mm} metientia, thecis 2.5^{mm} longis, staminodio 3^{mm} longo. Discus pulvinaris cum stylo 1.5^{cm} longo glaber, stigmatibus semiorbicularibus. Capsula ignota.

Tucurrique, Costa Rica, alt. 630^{m}, Jan. 1899, *Tonduz*, n. 13045 herb. nat. Cost.

Lophostachys Guatemalensis Donn. Sm.—Folia nascentia incano-pubescentia aetate provectiore praeter petiolum nervosque

glabrescentia disparia lanceolato-elliptica longe falcato-acuminata triente inferiore in petiolum arcuatim attenuata subtus pallidiora. Spicae terminales subsessiles solitariae, bracteis lanceolato-linearibus 5-nerviis, bracteolis spathulato-linearibus abrupte cuspidatis 2-nerviis. Calycis segmenta exteriora aequalia spathulato-oblonga cuspidato-acuminata, postico basi 7-nervio medio 5-nervio, antici usque ad medium fissi laciniis 3-nerviis. Stamina omnia perfecta.

Fruticulus decumbens dichotomo-ramosus, ramulis quadrangularibus. Folia 5–8^{cm} longa 1.5–3.5^{cm} lata supra saepe minutissime lineolata subtus ad costam nervosque pubescentia, petiolis pubescentibus 1–1.5^{cm} longis, axillis saepius folia duo minuta producentibus. Spicae foliis reductis suffultae 3–4^{cm} longae, bracteis 9–10^{mm} longis 2.5–3^{mm} latis triente superiore falcato-acuminatis et ciliatis ad nervos pubescentibus, bracteolis 9^{mm} longis inaequilateralibus ciliatis, altera angustiore. Calyx 1.5^{cm} longus sicut bracteolae erubescens et pulchre reticulatus ciliatus ad basin versus utrinque incano-pubescens ceterum minute puberulus, segmentis lateralibus subulatis 8^{mm} longis, postico 5^{mm} lato. Corolla purpurea (ut videtur), pubescens 3.3^{cm} longa, labio postico truncato-ovato 8–9^{mm} longo bidentato, antici 10–11^{mm} longi segmentis ovalibus 6^{mm} longis. Stamina medio tubo affixa, antica 17^{mm} longa, posticorum 13^{mm} longorum antheris unilocularibus polleniferis. Discus 1^{mm} altus, ovario oblongo-ovoideo 4^{mm} longo, stylo capillari 2.7^{cm} longo, ovulis ovalibus 1^{m} longis. Capsula non adest.— Ceteris speciebus adhuc descriptis, omnibus Brasiliensibus aut Peruvianis, haec bracteis bracteolis calycibus praecipue discrepat.

Casillas, Depart. Santa Rosa, Guatemala, alt. 1300^{m}, Jan. 1893, *Heyde* et *Lux*, n. 4382 Pl. Guat. &c., qu. ed. Donn. Sm.

Hernandia didymantha Donn. Sm.— Ramuli cum foliis petiolisque glaberrimi. Folia oblongo-ovata a medio linea arcuata sursum angustata basi obtusa aut rotundata penninervia. Paniculae folia superantes praeter involucella totae incanae, ramis secundariis bifloris, bracteis 4 oblongis. Flos masculinus solitarius 3-merus, pedicello filiformi. Flos femininus 4-merus, involucello truncato pyramidali subclauso, fructifero sphaerico drupam subaequimagnam arcte includente, semine globoso.

Arbor 15^{m} alta, trunco excelso, ramis inferioribus reflexis, superioribus erecto-patentibus, floribus porraceis (ex schedula et icone photographica Pitterianis). Folia 12–18^{cm} longa 4.5–7^{cm} lata tenuiter coriacea, nervis lateralibus

utrinque 7–8, petiolis glabris canaliculatis 3–6^{cm} longis. Paniculae circa 5 terminales et ex axillis foliorum superiorum decrescentium prodeuntes cum pedunculo 9–11^{cm} longo adjecto 19–23^{cm} longae corymbiformes densiflorae, ramis secundariis arcuatim adscendentibus, inferioribus 2–3^{cm} longis. Bracteae jam ante anthesin reflexae 8^{mm} longae 3.5^{mm} latae apice rotundatae. Floris masculini pedicellus filiformis 7^{mm} longus, altero anantho brevi rarissime exstante, segmenta 6 oblongo-elliptica 5^{mm} longa obtusa, glandulae 6 liberae subsessiles, antherae oblongae 1.5^{mm} longae filamenta aequantes. Floris feminini pedicellus 1^{mm} longus, involucellum coriaceum parce pubescens siccitate nigrescens 3^{mm} altum atque latum, ore integro 1^{mm} lato, segmenta 8 uti glandulae 4 masculinis similia, stylus sursum incrassatus et quadrangularis 4^{mm} longus, stigma obliquum subintegrum nudum. Involucellum fructiferum crasse coriaceum 2.2^{cm}-diametrale, drupa 1.9^{cm}-diametralis ecostata (ut videtur).

H. Guianensi Aubl. proxima recedit praesertim foliis penninerviis, flore masculino singulo graciliter pedicellato, involucello jam sub anthesi paene clauso, drupa minore.

Ad litora Atlantica prope Punta Mona, Costa Rica, Sept. 1898, *Pittier*, n. 12682 herb. nat. Cost.

Brosimum heteroclitum Donn. Sm.—Scandens. Folia membranacea glabrescentia oblongo-elliptica cuspidato-acuminata basi obtusa aut acutiuscula crenulato-serrulata, stipulis bracteisque a basi lata filiformibus. Receptacula in axillis duabus suprèmis approximatis solitaria sessilia maxima, masculinorum loculis 1–3, ovulis abortivis in quoque loculo pluribus.

Suffrutex in arborum truncis scandens et radicans, ramis virgatis 30–40^{cm} longis glabris. Folia nascentia pubescentia, vetustiora supra punctis minutis albidis scabriuscula costa nervisque pubescentia 10–16^{cm} longa 4.5–6.5^{cm} lata, nervis lateralibus utrinque 6–8, venis transversis subparallelis, petiolis 1–3^{cm} longis sicut stipulae bracteaeque 6^{mm} longae pubescentibus. Receptacula masculina globosa 1–1.3^{cm}-diametralia demum ovalia et usque ad 2^{cm} longa crasse corticata, ore bracteolis crassis ovatis munita, ovulis abortivis lateraliter affixis. Cetera desunt. Species habitu scandente et ovulis rudimentariis compluribus valde anomala. Receptacula vetustiora staminibus derasis tantum suppetunt.

Jiménez, Llanuras de Santa Clara, Costa Rica, alt. 250^{m}, Mart. 1896, *Donn. Sm.*, n. 5117, Pl. Guat., &c., qu. ed. Donn. Sm.

Pilea ptericlada Donn. Sm.—Dioica. Glabra. Folia oblongo-elliptica utrinque acuminata in petiolum brevem cuneato-attenuata

supra trientem inferiorem grosse crenato-serrata, nervis basilaribus trientem superiorem attingentibus et costa subtus explanatis fuscis, stipulis quam petiolis paulo brevioribus. Pedunculi feminini foliis breviores et cymarum axes alati.

Herbacea. Caulis e basi lignosa radicante assurgens in exemplis obviis 6–15^{cm} altus, nodis approximatis. Cujusve paris folia aequalia aequilatera triplinervia 5–11^{cm} longa 3–5^{cm} lata summa apice obtusiuscula supra cystolithis fusiformibus et punctiformibus farcta subtus plerumque nuda, foliis inferioribus minoribus, serraturis obtusis, costa nervisque supra immersis, stipulis orbiculari-ovatis 5–8^{mm} longis binerviis, petiolis 6–10^{mm} longis. Pedunculi 2–6^{cm} longi 2–3^{mm} lati, cymis pyramidatis 2–3^{cm} altis 2.5–3.5^{cm} latis, ramis ramulisque patulis circa 1^{mm} latis sicut pedunculi cystolithis obsitis. Perianthium sessile fructifer bracteolam cystolithis lineatam subaequans, segmentis parum inaequilongis, achenia ventricoso-ovata 2^{mm} longa perianthium dimidio superante rubro-punctulata et marginata. Planta masculina ignota. Secundum methodum Weddellianam juxta *P. elegantem* Wedd. locari debetur.

In sylvis udis Atirrensibus, Prov. Cartago, Costa Rica, alt. 600^{m}, Apr. 1896, *Donn. Sm.* n. 6779 Pl. Guat., &c., qu. ed. Donn. Sm.; Suerre, Llanuras de Santa Clara, Costa Rica, alt. 300^{m}, Apr. 1896, *Donn. Sm.* n. 6780 Pl. Guat., etc., qu. ed. Donn. Sm.—Eadem planta, ut videtur, sub nn. 172 et 199 *Endres* in herb. Kew. exstat.

Costus sanguineus Donn. Sm.— Pallide ferrugineo-villosus. Folia discoloria supra bulboso-pilosa oblanceolato-oblonga acutissime acuminata basi minute rotundata subsessilia. Strobilus lanceolato-ovoideus, bracteis pilosis oblongo-ovatis superne infra apicem carinatis, infimis apice foliaceis. Calyx prima tertia parte acute lobatus. Corolla sanguinea, labello pubescente oblongo apice angustata truncata 5-lobulato, ceteris segmentis anguste lanceolato-oblongis, connectivo triangulari labellum paulo superante. Ovarium pilosum.

Ochreae laciniis scariosis usque ad 2^{cm} longis marginatae saepius reticulato-striatae cum vagina extus villosae et intus glanduloso-punctulatae. Folia subtus sericea et ad costam longe villosa 14–22^{cm} longa supra medium 4.5–6.5^{cm} lata basi 8–10^{mm} lata, nervis omnibus a basi prodeuntibus. Strobilus 7–10^{cm} longus circa 3^{cm} crassus, bracteis coriaceis sanguineis circa 4^{cm} longis 20–23^{mm} latis, bracteola 1 pubescente lineari-oblonga 18^{mm} longa 6^{mm} lata acuminata, floribus sub quaque bractea singulis. Calyx campanulatus 8–9^{mm} altus pilosus striatus. Corolla purpureo-coccinea (von Tuerckheim in sched.) 5.5–6^{cm} longa, labello 3.3^{cm} longo 1.5^{cm} lato a triente superiore deorsum paulo

angustato, lobulis oblongis 3^{mm} longis rotundatis, ceteris segmentis 26–28^{mm} longis 7–9^{mm} latis, filamento 9–10^{mm} lato, connectivo 7^{mm} longo in caudiculam marginibus revolutam producto, anthera 8^{mm} longa, loculis 1^{mm} inter se distantibus. Ovarium breviter oblongum 5^{mm} longum, stigmate semilunari 3^{mm} lato ciliolato, appendice dorsali ovali apice retusa. Capsula ignota.— *C. spicato* Sw. proximus differt praecipue indumento et florum indole atque colore.

Cubilquitz, Depart. Alta Verapaz, Guatemala, alt. 350^{m}, Maj. 1900, *von Tuerckheim*, n. 7686 Pl. Guat. &c., qu. ed. Donn. Sm.

ISCHNOSIPHON MORLAE (Eggers, Bot. Centralbl. **53**: 307. *pl. 2*) **leiostachya** Donn. Sm.—Spicae glabrae, bracteis magis elongatis.—Ceteroquin exempla Centrali-Americana cum specimine typico Ecuadoriensi in herb. Kew. asservato prorsus congruunt.

San Pedro Sula, Depart. Santa Barbara, Honduras, alt. 300^{m}, Sept. 1888, *C. Thieme*, n. 5519 Pl. Guat. &c., qu. ed. Donn. Sm.; Las Vueltas, Tucurrique, Prov. Cartago, Costa Rica, alt., 635^{m}, Dec. 1898, *Tonduz*, n. 12884 herb. nat. Cost.

Calathea dasycarpa Donn. Sm. (§ EUCALATHEA Koern.)—Folia glabra oblonga 3–4-plo longiora quam latiora in cuspidem gracilem acuminata basi rotundata in articulum cuneato-producta, folio inflorescentiam suffulciente caulinis simili longe petiolato. Pedunculus petiolo brevior bifidus. Spicae pro ratione parvae oblongae interdum basi furcatae, bracteis distichis vix ac ne vix imbricatis dimidiato-ovatis cymbiformibus coriaceis ad margines barbatis, floribus paucis binis. Corollae tubus sepalis 3-plo longior intus villosissimus. Ovarium pilosum. Fructus monospermus.

Folia 60–80^{cm} longa prope medium 18–19^{cm} lata ad costam subtus pubescentia, cuspide lineari 1.5–2.5^{cm} longa, petiolis cum articulo glabro 5–6^{cm} longa adjecto 43^{cm} longis pilosiusculis. Pedunculus 21^{cm} longus basi bractea 10^{cm} longa apice bractea 3.5^{cm} longa suffultus, ramis 3–5^{cm} longis. Spicae 6–9^{cm} longae, rachis internodiis inferoribus 10–18^{mm} longis, bracteis 10–12 demum late patulis circa 2^{cm} longis 9^{mm} latis, bracteolis 2 late oblongis 10–14^{mm} longis, exteriore bicarinata et dentibus rotundatis 3-lobulata, interiore minore unicostata integra, floribus plerumque 4 minute pedicellatis. Sepala lanceolata 7–9^{mm} longa. Corollae pallide luteae (Pittier in sched.) tubus 28^{mm} longus intus valde pluri-costatus. Ovarium obovatum 3^{mm} longum dense longeque adpresso-pilosum, ovulo abortu unico triquetro. Fructus ovalis 10^{mm} longus 5^{mm} latus pilosus, pericarpio membranaceo nervoso, semine

atro-purpureo oblongo 4.5^{mm} longo corrugato. Corolla cum androecio marcida tantum suppetit.

In sylvis ad oras Rio Hondo prope Madre de Dios, Comarca de Limón, Costa Rica, alt. 200^{m}, Nov. 1896, *Pittier*, n. 10350 herb. nat. Cost.; Agua Buena, Cañas Gordas, Comarca de Limón, Costa Rica, alt. 1100^{m}, Feb. 1897, *Pittier*, n. 11136 herb. nat. Cost.

Calathea lasiostachya Donn. Sm. (§ EUCALATHEA Koern.)—Folia glabra elongato-ovata apice acuminata inferne rotundata ima basi cuneata, folio inflorescentiam suffulciente conformi dimidio minore petiolis usque ad articulum vaginatis bis longiore. Pedunculi 3-ni petiolum subaequantes. Spicae elongato-oblongae sordide villosae, bracteis stricte distichis late patentibus conduplicatis membranaceis. Ovarium glabrum. Fructus dispermus.

Caulis robustus elatus. Articuli cum vaginis pedunculisque pilosiusculi. Folia 86^{cm} longa 23^{cm} lata a triente inferiore sursum angustata, articulis 9^{cm} longis, petiolis longissimis, vaginis scabriusculis. Folium sub inflorescentia 40^{cm} longum 15^{cm} latum, petiolo cum articulo 3^{cm} longo adjecto 21^{cm} longo. Pedunculi 15–22^{cm} longi ad apicem versus villosi. Spicae 11.5–17^{cm} longae 5.5–6^{cm} latae, lateribus subparallelis. Bracteae 22–32 sublaxe imbricatae dimidiato-ellipticae subfalcatae 3.5^{cm} longae 1.5^{cm} latae intus sericeae, omnes conformes, bracteolis lineari lanceolatis et linearibus circa 2^{cm} longis. Ovarium nitido-atrum oblongum 6^{mm} longum 4^{mm} latum 3-loculare abortu 2-ovulatum. Fructus laevis pallidus ellipticus 12^{mm} longus 6^{mm} crassus, pericarpio pergameneo intus valde reticulato, valvis 3 inaequilatis, minoribus latere septatis, seminibus atris 8^{mm} longis arillosis. Perianthium deficit.

In sylvis ad oras Rio Hondo prope Madre de Dios, Costa Rica, alt. 200^{m}, Nov. 1896, *Pittier*, n. 10344 herb. nat. Cost.

Calathea Verapax Donn. Sm. (§ MONOSTICHE Koern.)—Glabra. Acaulis. Folia inaequilatera elliptica vel ovato-elliptica acuminata ima basi in articulum brevem producta petiolis subaequilonga. Scapus nudus petiolum superans usque ad medium bractea radicali inclusus basi petiolo et bracteis cinctus. Spica obovato-elliptica, bracteis membranaceis coloratis numerosissimis lanceolatis filiformi-attenuatis subaequilongis. Corollae tubus sepalis linearibus dimidio longior, lobi lanceolati.

Rhizoma bracteas 7–20^{cm} longas apice denticulata petiolos 2 scapumque involventes emittens, petiolo altero toto fere vaginato alterum nudum

includente. Folia 20–30^{cm} longa 9.5–14^{cm} lata, petiolis cum articulo 1–2^{cm} longo adjecto 29–33^{cm} longis. Scapus 35–55^{cm} longus. Spica 8–12^{cm} longa circa 4^{cm} lata, rhachi 5^{cm} longa, bracteis in sicco rubescentibus erecto-patentibus, infimis 6.5^{cm} longis 1.8^{cm} latis, supremis 6^{cm} longis 9^{mm} latis, bracteolis 3 late oblongis 1.7^{cm} longis, exteriore valde bicarinata, floribus 2–4-nis. Sepala 2.1^{cm} longa 2.5^{mm} lata. Corollae coccineae (ut videtur), tubus 3^{cm} longus, lobi 1.5^{cm} longi 5^{mm} lati acuti. Androecii labellum 1^{cm} longum 7^{mm} latum, lobus cucullatus appendice filiformi 4^{mm} longa instructus, staminifer anthera 2.5^{mm} longa superatus. Stylus incurvus, stigmate valde inflexo. Ovarium glabrum oblongo-obovatum 3-loculare. Fructus non adest.—Ad *C. Petersenii* Eggers habitu accedens spica et florum fabrica recedit.

Rubelcruz, Depart. Alta Verapaz, Guatemala, alt. 1000^{m}, Maj. 1887, *von Tuerckheim*, n. 1269 Pl. Guat. &c., qu. ed. Donn. Sm.; Sacolal, Depart. Alta Verapaz, alt. 1000^{m}, Apr. 1889, *Donn. Sm.*, n. 1779, Pl. Guat. &c., qu. ed. Donn. Sm.

Callisia grandiflora Donn. Sm.— Folia a basi rotundata sessili elliptico-lanceolata. Cyma elongata cincinnalis, pedicellis compluribus, floribus 3-meris maximis. Stamina fertilia 3, filamentis sursum barbatis, loculis divergentibus connectivo amplissimo brevioribus. Stamina sterilia 3 nuda. Capsula 3-valvis, loculis monospermis.

Praeter ocreas ciliatas glabra. Folia 6–12^{cm} longa 1.5–2.5^{cm} lata acutissima. Cyma paniculiformis 6–11^{cm} longa, rhachi flexuosa, axibus primariis 1.5–2.5^{cm} longis, lateralibus 7–20^{mm} longis, bracteis inferioribus foliaceis 1–5^{cm} longis, superioribus depauperatis sicut bracteolae minimae subspathaceis, pedicellis circa 5–9-fasciculatis 7–10^{mm} longis. Sepala herbacea albopunctata oblongo-elliptica 6.5^{mm} longa 2.5^{mm} lata sub anthesi reflexa. Petala ex schedula Tuerckheimiana alba in sicc. pallide flavescentia oblongo-elliptica 9^{mm} longa 4^{mm} lata obtusa. Stamina fertilia 6–7^{mm} longa, pilis aureis longissimis densissimis, antheris cinnabarinis transversim ovalibus 1.5^{mm} latis utrinque praesertim apice bifidis, loculis oblongis 0.5^{mm} longis subdivaricatis. Stamina imperfecta 2–3^{mm} longa, loculis connectivo parvulo subdiscretis. Ovarium ovale 1^{mm} longum stylum aequans, stigmate capitellato papilloso. Capsula ovalis 5–6^{mm} longa abortu saepius bisperma, seminibus erubescentibus rugulosis elongato-oblongis 4^{mm} longis.—Species staminibus et perfectis et rudimentariis abnormalis ad Tradescantiae sect. Descantariam accedens.

In dumetis et frutectis prope Cubilquitz, Depart. Alta Verapaz, Guatemala, alt. 350^{m}, Mart. 1900, *H. von Tuerckheim*, n. 7684 Pl. Guat. &c., qu. ed. Donn. Sm.

Baltimore, Md.

BRIEFER ARTICLES.

NITRATES AS A SOURCE OF NITROGEN FOR SAPROPHYTIC FUNGI.

The readiness with which different classes of plants make use of nitrogenous inorganic material has been variously demonstrated. It is well understood that salts of nitric acid, and to a less extent ammonia, serve as nutrient material for the higher plants, and that free nitrogen and salts of nitrous acid are worked upon by certain bacteria in such a way as to make them available as a nitrogen food supply. But Pfeffer[1] states that phanerogams and saprophytic fungi are unable to assimilate nitrites.

With a view of testing this latter point certain fungi were grown in culture solutions containing ammonium chlorid, potassium nitrate, potassium nitrite, hexamethylenetetramine, and peptone. The culture was prepared with 200^{cc} chemically pure water obtained by redistilling from á solution of potassium permanganate until free from every trace of ammonia, 10^{gr} cane sugar, 0.5^{gr} magnesium sulphate, 0.1^{gr} acid potassium phosphate, and a trace of ferric chlorid. To 10^{cc} of the sterilized solution was added 0.1^{gr} of one of the nitrogen containing substances. One drop of this preparation placed on a cover glass was inoculated with the fungus and the cover glass inverted over the cell and placed in the thermostat for cultivation at 28° C. The fungi used for inoculation were *Aspergillus flavus* and *Botrytis vulgaris*. Throughout the experiment care was taken to have the solutions and apparatus thoroughly sterilized, and all of the salts used were chemically pure.

Duplicates of each were prepared, also checks using the solution without the nitrogen containing compound. The cultures were examined at intervals for from one to three days. At the expiration of the time unquestionable results were obtained. In potassium nitrate and potassium nitrite the fungi grew with apparently equal vigor, Aspergillus developing well formed fruit bodies. Hexamethylenetetramine showed itself an excellent source of food, since both fungi grew and

[1] Physiology of Plants, translated by Ewart, 406. 1899.

fruited in it. In peptone the fungi grew rapidly and luxuriantly, proving it to be a favorable source of nitrogen.— MARY H. SMITH, *Botanical Department, Cornell University.*

NON-SEXUAL PROPAGATION IN OPUNTIA. II.

A VERY interesting Opuntia which has recently come to my notice in studying the various propagative methods of the Cactaceae is *O. arbuscula* Engelm., a small, more or less arborescent form, densely branched, and reaching a height of about 15^{dm}. This plant sets an abundance of fruit which appears to mature well, but which upon examination is found to contain very few good seeds. So laden is the plant with its fruit that its branches, as a rule, bend over so as almost, if not quite, to touch the ground. In this position there takes place a process analogous to "layering," new shoots of an apparently primitive character arising from the decumbent branches, which also give off roots into the soil. The same formation of primitive shoots occurs in joints detached from the parent plant. This is also true of fruits, from the sides of which both stems and roots may often be found forming, so often, in fact, that this must be regarded as the rule rather than the exception. We have here the case of a structure, modified primarily for sexual purposes, turned finally to use in a non-sexual way, to accomplish, broadly speaking, the same end.

Still another method of propagation, perhaps not very common, yet apparently not infrequent with this species, is by the formation of adventitious shoots on the roots. The roots are, in this form as in the majority of the Cactaceae, divided into two systems, as already described.[1] On the absorptive roots, which run just below the surface, there arise, at some distance from the main plant, adventitious shoots of a character far more primitive than those formed on fruits or fallen joints. The leaves of these shoots are in some cases over 10^{mm} long, green, and succulent. By the time these shoots reach the height of about 2^{dm}, the root connecting them with the parent plant dies, thus leaving them independent at an early stage.

The distribution of this species is very well defined. It occurs almost exclusively in those slight depressions in the plain, which in time of hard rains are washed by broad and shallow streams of surface

[1] BOT. GAZ. 30 : 348 *seq.* 1900.

water. Here it grows in colonies, following the lines of the depressions. The soil in such places is much finer and less pebbly than that on the slight elevations near by, but experiments in transplanting have demonstrated that this distribution is not due to soil characters. It seems probable that the fruits and joints are washed down by the stream, and settle at various places along the course. From the single plants so started colonies soon are formed, through the agency in part, it may be supposed, of root propagation and "layering."—CARLETON E. PRESTON, *Harvard University*.

CURRENT LITERATURE.

BOOK REVIEWS.

A new school botany.[1]

At least three things must be considered in making an estimate of a text-book, namely, its style, its reliability, and its pedagogical standpoint. Professor Bailey's style is too well known to need description or commendation. He is one of our clearest and most forceful writers. The general facts of botany are fairly well established and are common property, so that the preparation of an elementary text involves merely selection from a great mass of well-known material. In the book before us, therefore, there is no occasion to discuss style or reliability, although in the latter feature Professor Bailey is as great a sinner as the rest of us. In regard to the pedagogical standpoint, however, he has raised a distinct issue and this deserves statement and some discussion. The author has had an extensive experience with teachers and schools, and his verdict is that "the schools and the teachers are not ready for the text-book which presents the subject from the view-point of botanical science." To discover the explanation of this statement by means of his book, it becomes evident that the author does not believe in the organization of botanical material so that some conception of the science as a whole may be developed. From his point of view the study need not develop the idea of relationships, or need not be used to illustrate principles. The selection of material is to be made from forms and phenomena which are familiar, and which are related to the experiences of the daily life. All of this means that in the judgment of the author the average recent botanical text is not adapted to the majority of teachers and of schools as they are, but overshoots them.

At least two objections to this view have doubtless had weight with those botanists who have prepared texts from a different standpoint, namely, the conviction that pupils of secondary-school age are ready for some organization of a science, and the further conviction that teaching can only be improved when some pressure is brought to bear upon teachers to become properly trained. It should be said that the author distinctly disclaims any criticism of existing text-books, but recognizes the need of one adapted to actual rather than to ideal conditions.

An illustration of the result of not keeping hold of some little thread of continuity may be found in Professor Bailey's chapter XXV, entitled

[1] Bailey, L. H.: Botany, an elementary text for schools. 8vo. pp. xiv+356. New York: The Macmillan Company. 1900. $1.10.

"Studies in cryptogams." In our judgment this chapter will be unintelligible or misleading to those who have had no other preparation for it than that obtained from the preceding chapters. This is no criticism of the chapter as to its contents, but as to its pedagogical soundness.

Another position taken by the author deserves attention. He says: "There are other ideals than those of mere accuracy. In other words, it is more important that the teacher be a good teacher than a good botanist. One may be so exact that his words mean nothing." The writer sympathizes with the thought in Professor Bailey's mind, for he has encountered these oppressively accurate and insistent teachers, whose mania for precision kills inspiration; but he doubts whether teachers in the secondary schools need any encouragement to be inaccurate. It would seem evident that reasonable accuracy, as opposed to pedantic accuracy, and inspiration should coexist in the teacher. If there is anything for which science stands, and in which it should train even the very young, it is a reasonable accuracy.

The four general subjects presented in the book are the nature of the plant itself; the relation of the plant to its surroundings; histological studies; and determination of the kinds of plants. From the pedagogical standpoint the author regards the third as the least important. The book is full of suggestive material for the teacher, and the illustrations are very attractive. The experiment suggested by Professor Bailey is worth the trial, and no teacher should be so confident of his own methods as not to await the outcome with keen interest.—J. M. C.

The Umbelliferae.

JUST TWELVE YEARS after the appearance of their first *Revision* of North American Umbelliferae, Drs. Coulter and Rose have brought out a new monograph of the same group, which appears to be a model of what such work should be.[2]

From the time of Linnaeus to the treatment of our Umbelliferae by Torrey and Gray, eighty-seven years, thirty authors wrote on the group, producing forty-one books and papers, which contained 195 new species or names. In the next forty-seven years, up to the appearance of the *Revision* of Coulter and Rose, twenty-seven writers, in fifty-seven contributions, introduced 258 new names or species in the group. And in the last twelve years nineteen persons, contributing forty-three papers, have added 108 new species and names. The *Monograph* now issued (as it chances, on the last day of the century) describes and places 332 native species and 39 which are considered as introduced, or a total of 371, in contrast with 233 included in their earlier *Revision*. No comment is needed on this as an indication of the rapidity with which the understood components of our flora are changing.

[2] COULTER, JOHN M., and ROSE, J. N.: Monograph of the North American Umbelliferae. Contr. U. S. National Herbarium 7: 1–256. *pls. 1–9. figs. 1–65.* 1900.

In addition to what appear to be serviceable keys to the genera and species, that which is now believed to be their necessary bibliography and synonomy, adequate descriptions, and a full citation of material examined, the work contains a large amount of tabular and statistical matter, which if not of interest to the ordinary seeker after the name of a plant, at least shows the painstaking care that has been bestowed on the study. An interesting feature is a table of data concerning the specimens which have served for illustration, and as all of the sixty-two native and sixteen introduced genera are figured, both as to the appearance of their fruit and its cross section, this information is of no little importance for those who in future may have to familiarize themselves with what these genera now stand for.

That all but four of some 800 references have been verified not only shows the industry of the authors but ensures the trustworthiness of their statements in this, a feature which is too often lamentably misleading to the men who compile from unverified citations.

The most conspicuous changes are as follows: *Coloptera* C. & R. is found to represent true *Cymopterus*, and the Cymopterus aggregate of the former *Revision* is distributed under four genera, two of them new (*Aulospermum* and *Rhysopterus*), and two of them Nuttallian (*Phellopterus* and *Pteryxia*); *Peucedanum* L. is found to have no indigenous species in North America, and this greatest of our umbelliferous genera becomes known as *Lomatium* Raf., certain groups of species heretofore included being recognized as genera, as *Cynomarathrum* Nutt. and *Euryptera* Nutt.; *Centella* L. is recognized as distinct from *Hydrocotyle*; *Deweya* T. & G. is restricted to its type species, and a new genus, *Drudeophytum*, established to include the other species variously described under Deweya, Velaea, and Arracacia; and *Sphenosciadium* Gray is taken out of *Selinum*. As a result of these and other changes, the following generic names disappear from our flora: *Coloptera* C. & R., *Crantzia* Nutt., *Cryptotaenia* DC., *Discopleura* DC., *Leptocaulis* Nutt., *Osmorhiza* Raf., *Peucedanum* L., *Phellopterus* Benth., *Selinum* L., *Tiedemannia* DC., and *Velaea* DC.

All-in-all, though changes are not unlikely to occur that may relatively soon cause us to look upon this as merely work of the last century, it appears to be of such a character that the twenty-first century will still see it at the elbow of every advanced and attentive student of the Umbelliferae of our country.—WILLIAM TRELEASE.

MINOR NOTICES.

THE THIRD FASCICLE of the second volume of Pittier's *Flora of Costa Rica*[3] has appeared. The first fascicle contained the Polypetalae (excepting

[3] PITTIER, H.—Primitiae Florae Costaricensis. Vol. II, pp. 219–294. Piperaceæ, by Casimir de Condelle. San José de Costa Rica. 1899. $1.

Polygalaceae, Sapindaceae, Meliaceae, Leguminosae, and Melastomaceae), by John Donnell Smith. The second fascicle included the Gamepetalae (excepting Rubiaceae, Compositae, Solanaceae, Convolvulaceae, Acanthaceae, and Labiatae), by the same author. The present fascicle presents the Piperaceæ, by Casimir de Candolle, who calls attention to the close affinity of the flora to that of South America. The two genera are Piper and Peperomia; the former containing eighty-three species, fifty-one of which are described as new; the latter forty-three species, twenty-one of which are new.—J. M. C.

PROFESSOR KARL SCHUMAN has begun the publication of *Blühende Kakteen* (*Iconographia Cactacearum*), with the assistance of the Deutsches Kakteen-Gesellschaft. Each part is to contain four colored plates, with descriptive text, and is sold for four marks. It is expected that about three parts will be issued each year. The first part contains *Echinocactus microspermus* Web., *Echinopsis cinnabarina* Lab., *Echinocereus subinermis* Salm-Dyck, and *Echinocactus Anisitsii* K. Sch., the last being a new species from Paraguay. The plates are beautifully colored illustrations of the plants in bloom, made from nature by Frau Dr. T. Gürke. The text, by Professor Schuman, needs no comment. The publisher is J. Neumann, Neudamm, Brandenburg, Germany.—J. M. C.

DR. A. J. GROUT'S *Mosses with a hand lens*[4] describes in nontechnical language 100 of the mosses of the northeastern United States which can be recognized with some degree of certainty by the use of a simple lens. The identification in many cases must be limited to the genus, the specific differences being too recondite for observation in this way. Miss Thayer's excellent drawings will be quite as helpful to the student as Dr. Grout's text. A key based upon the more apparent structural characters, and one based upon habitat, would need to be tested before pronouncing judgment upon them, but they are here and there unavoidably somewhat vague, which always detracts from the value of a key. The only danger from the use of such a book will be that beginners will not heed sufficiently the author's cautions, and will be too sure of their determinations. But if properly used the book will stimulate interest in the mosses and lead on to more exact study.

The glossary has concise and accurate definitions, elucidated by admirable illustrations. It would have been more serviceable had it been arranged in one alphabetic sequence instead of being divided into several. One must first know to what his strange word is applicable before he can tell in what group to look for it.—C. R. B.

[4] GROUT, A. J.: Mosses with a hand lens. A nontechnical handbook of the more common and more easily recognized mosses of the northeastern United States. Illustreated by Mary V. Thayer. 8vo. pp. xii+74. *pls. 8. figs. 90.* New York: The Author, 360 Lenox Road, Flatbush. 1900.

NOTES FOR STUDENTS.

IN TWO PAPERS[5] Dr. Bessey states that some recent observations of his have lead him to think that the greater portion of the state of Nebraska is capable of supporting a tree vegetation. He claims that the absence of trees is due to the prairie fires, and that now wherever given a chance the tree area of the state is spreading.— H. N. WHITFORD.

ACCORDING TO MIYAKE[6] the majority of the leaves of Japan evergreens are found to contain more or less starch in winter, only one third of the species being devoid of it altogether. The starch content in winter, however, is considerably decreased; this decrease begins in November, the minimum of starch is found in January, and the amount increases again in February. The author also shows that starch is actually manufactured in winter, though much less than in summer.— H. C. COWLES.

NEMEC asserts[7] that in certain plant parts, *e. g.*, the root, where transmission of a stimulus occurs, there are embedded in a special plasma fibrils, the clusters of which, by proper staining, may be made easily visible with moderate magnification. These fascicles correspond on opposite sides of the partition walls and presumably are continuous or at least in contact through it. Experiment has shown that conduction of a stimulus is more rapid in the direction of these fibrils than across them, and that after their degeneration this difference in rate disappears. The perceptive region of the root, he declares, lies mostly in a special group of cells in the root cap. These are characterized by a very fluid plasma, and permanent starch grains which easily sink through it to rest on the ectoplasm. Fibrils extend from these cells to the region of curvature. In some roots this group of cells becomes a special organ, which may be compared in principle with the organs of equilibrium (vesicles with statoliths) in certain lower animals. (Cf. Noll, rev. in BOT. GAZ. **30**: 134. 1900.)—C. R. B.

MR. JAMES A. TERRAS, of Edinburgh, has examined the conditions under which the winter buds of *Hydrocharis Morsus-ranæ* germinate. This plant propagates itself by buds, formed at the extremities of the subaqueous runners, in which is stored an abundant supply of reserve proteid, apparently a fluid albumin. The autumnal buds separate as soon as mature and sink to the bottom, where they rest till the following spring, or longer if covered by mud to the depth of two or three centimeters. It seems that this cover is effective merely because it cuts off the light, any other opaque screen likewise preventing germination. Indeed if merely much shaded the buds do

[5] The forest and forest trees of Nebraska. Reprint from Report of Nebraska Board of Agriculture, pp. 79–102. 1899.

The natural spreading of timber areas. Forester **6**: 240–243. 1900.

[6] Bot. Mag. **14**: 44–49. 1900.

[7] Biologisches Centralblatt **20**: 369. 1900.

not develop. Experiments with colored liquid screens show that yellow and orange rays are most efficient, as Heald found in studying the germination of moss and fern spores. Heat apart from light is incapable of inciting to development; and no supply of food, either carbohydrate or nitrogenous, awakens to activity. No zymogen was found in resting buds, and Terras concludes that the primary effect of light is to stimulate the protoplasts to activity, leading to the development of a zymogen, which in its turn is converted under the influence of the light into a zymase by which the utilization of the stored food becomes possible.—C. R. B.

IN HER RECENT WORK on Lavatera,[8] Miss Byxbee describes a process of spindle development as follows: In the young pollen mother cells the cytoplasm consists of a fibrous network and a granular substance. As division approaches, the network surrounding the nucleus pulls out parallel to the membrane, forming a felt of fibers, and at the same time the granular substance of the cytoplasm collects in a wide dense zone about the nucleus. The nuclear wall now breaks down, and the fibers outside begin to grow into the nuclear cavity and mingle with the linin threads, which appear to have increased in quantity. This central mass of fibers now grows out into several projections, which become the cones of the multipolar spindle. Two of these cones become more prominent than the others, which they finally absorb, and the result is a bipolar spindle. Just how this absorption of the smaller cones is brought about is not made clear either in the description or in the figures.

The work is well illustrated by four beautiful lithographic plates. While the results differ in certain minor details from previous work on the subject, it confirms the more important points that have already been worked out in such forms as Equisetum, Cobaea, Passiflora, Gladiolus, etc. The paper is an addition to the very interesting series of contributions on spindle formation recently issued from the Botanical Laboratory of the University of California.

Flemming's strong solution, with an excess of acetic acid, palladium chlorid, and iridium chlorid, to which a small quantity of glacial acetic acid was added, were used for fixing; saffranin, gentian violet, and orange G were used for staining.—A. A. LAWSON.

THE GEOLOGICAL SURVEY of New Jersey has just issued a publication[9] which contains some valuable information concerning the forests of that state. In this C. C. Vermeule discusses the physical conditions of the forests of the state, and gives some field notes on forest conditions. Gifford Pinchot

[8] BYXBEE, EDITH SUMNER: The development of the karyokinetic spindle in the pollen mother cells of Lavatera. Cal. Acad. Sci. III. Bot. **2**: 63–81. *pls. 10–13.* 1900.

[9] Annual Report of the State Geologist for 1899. Report on forests. Geol. Surv. of New Jersey, pp. ix+327, *pls. 21*, with *maps.* 1900.

writes on the effects of fire on forest production, and on the plains, and adds some silvicultural notes on the white cedar. The last two topics are incorporated in the present volume from former reports of the survey.

By far the most useful part of the report from an ecologic standpoint is a paper discussing the relation between forestry and geology, by Dr. Hollick. This is a revision of a paper of the same title published in the January and February (1899) numbers of the *American Naturalist*. It contains a discussion of the existing conditions of the forests and their historic development. The state is divided into coniferous, deciduous, and tension zones. The coniferous zone lies to the south, which has for the most part barren soil conditions. In better soil conditions in the north is the deciduous zone, and the tension zone lies between these. Dr. Hollick draws the conclusion that "the coniferous zone is destined to be ultimately obliterated, or only to exist over limited areas, often for the negative reason that in such areas the conditions may not be favorable for other types of vegetation."

In part three of the report John B. Smith treats of the rôle of insects in the forest; and part four contains an article by John Gifford on the forestal conditions and silvicultural prospects of the coastal plain of the state, with remarks in reference to other regions. Other valuable features of the report are a large number of half-tone reproductions from photographs, and maps showing geological formations, distribution of rainfall, and distribution of forest areas.— H. N. WHITFORD.

ITEMS OF TAXONOMIC INTEREST are as follows: C. H. BISSELL (Rhodora **2**: 225. 1900) has described a new variety of *Zizia aurea* from Connecticut.—Two new genera of Hymenogasters have been described recently: *Arcangeliella*, by F. CAVARA (Nouvo Giorn. Bot. Ital. **7**: 117–128. *pl.* 7, 1900), from the coniferous forests of Vallombrosa, Etruria; and *Martellia*. by O. MATTIROLO (Malpighia **14**: 39–110. *pl.* 1. 1900), from Sicily.— L. PETRI (Malpighia **14**: 111–139. *pls.* 2–4. 1900) has described a new genus of Gasteromycetes from Borneo, *Clathrogaster* by name.—H. T. A. HUS (Zoe **5**: 61–70. 1900) has published a preliminary synopsis of the west coast species of *Porphyra*, recognizing thirteen species and varieties, four of which are described as new.— S. B. PARISH (*idem*, 71–76) has begun a series of papers entitled "Contributions to Southern California Botany," the first containing new species or varieties under *Sphaeralcea*, *Gilia*, *Galium*, *Eupatorium*, and *Bidens*.—T. S. BRANDEGEE (*idem*, 78–79) has described a new species of *Tapirira* from Lower California.— MISS ALICE EASTWOOD (*idem*, 80–90) has described new Californian species under *Salix*, *Chrysopsis*, *Helianthella*, *Sphacele*, *Mimulus*, *Aphyllon*, *Asclepias*, *Cleomella*, *Peucedanum*, and *Navarretia*.—C. L. POLLARD (Proc. Biol. Soc. Washington **13**: 184. 1900) has described a new Helianthus (*H. agrestis*) from Florida.— SCRIBNER and MERRILL (Division of Agrostology, Circular 27, Dec. 4, 1900) have described

two new species of *Eatonia* from the southern states.— RUDOLPH SCHLECHTER (Mém. de l'Herb. Boiss. 21: 1–78. 15 N. 1900) has published a monograph of the *Podochilinae* (a group of orchids including four genera), much enlarging the borders of *Podochilus*, recognizing forty-seven species in it, and describing five as new; describing a new genus, *Lobogyne;* and recognizing six species in *Thelasis*, and two in *Oxyanthera*.—J. M. C.

MESSRS. D. H. SCOTT and T. G. HILL have published[10] an account of the structure of *Isoetes Hystrix*, a terrestrial species, dealing entirely with the vegetative organs. Some of the results are as follows:

Stem.— There is some evidence of a single apical cell; the stele is not composed of united leaf traces, but is cauline, as in the simpler lycopods; two cambiums are developed, in some cases the outer, in other cases the inner first; well-differentiated phloem is always present in the intracambial zone, being continuous with the leaf traces.

Leaf.— The vascular bundle in the lamina has exarch structure, the protoxylem lying next the phloem; the phloem contains true sieve tubes with transverse and lateral sieve plates, on both of which callus is formed; growth is intercalary, except at first; the labium and velum are derived from tissue above the sporangium, and not from sterilized sporogenous tissue.

Root.— The stele has a monarch structure throughout, the differentiation of the xylem beginning with the development of a single tracheid; the apex is distinctly layered, the initial groups giving rise to plerome, and to inner and outer cortex.

In the conclusion of the paper the authors discuss the systematic position of the genus, presenting strong arguments in favor of its affinity with the Lycopodiales, in which group it seems to have some real affinity with Selaginella, but not close enough to include the two in the same family. "The relationship of Isoetes to the Lepidodendreæ is probably a nearer one." The authors regard the genus as one reduced from a much more complex type, and in no sense a primitive form of the leafy sporophyte. They would regard it "as a group that has long hovered on the limit of terrestrial and aquatic life, some of the forms becoming wholly submerged, while a few have definitely betaken themselves to dry land, a large proportion leading a more or less amphibious existence." — J. M. C.

ONE OF THE greatest ecological investigations of the day has been delayed if not permanently checked by the untimely death of the brilliant young Scotch botanist, Robert Smith, of Dundee. Inspired largely by Flahault, he attempted to do for Scotland what the latter is doing for southern France, viz., make a detailed ecological survey of the country. Since 1896 Smith has worked unceasingly at his task, and had published but the

[10] Annals of Botany **14**: 413–454. *pls. 23, 24.* 1900.

first two installments[11] when death put an end to his labors. In 1894 Flahault conceived the idea of making an ecological map of France,[12] especially with regard to the forests and agricultural areas. In 1897 the first sheet, corresponding in a way to the topographic sheets of our national geological survey, was published.[13] The maps are made on the scale of 1 : 200,000, and each plant association is represented by a given color. Flahault has adopted twenty-two conventional color tones, which also in a general way show the topographic relief, lowlands having light and highlands dark colors. Contour lines are used as on ordinary topographic sheets. Smith studied with Flahault at Montpellier and then turned his enthusiastic attention to his native country.

In 1899 Robert Smith published an interesting paper on the study of plant associations,[14] in which was given a historical summary of plant society studies from Humboldt down to Warming and Flahault, together with suggestions for use in field work. The two sheets which the author published give evidence of the most careful work, and cause us to regret that we shall not soon see any more. The Edinburgh sheet deals largely with lowlands and hence with cultivated areas. The littoral vegetation consists of marsh, dune, and rock plants, all of which the author regards as halophytic. The dominating forest trees are oaks on the plains and hills, pines and birches on the mountains, and alders in the swamps, though but little natural forest remains. In the higher areas are many dry, medium, and wet heath associations. The North Perthshire sheet has to do with a mountainous district. The maps are finely executed in colors that show strong contrasts. In America no comprehensive work like that of Smith or Flahault has yet been done, though the excellent mapping of our forest reserves under Gannett's supervision, published in the nineteenth and twentieth annual reports of the director of the United States Geological survey, does a similar grade of work for the forests. Professor Geddes[15] has given a very appreciative sketch of Robert Smith, which shows how his loss was felt at home.—H. C. COWLES.

THE CURIOUS PARASITIC Balanophoraceæ have always excited interest, but especially so since the appearance of the papers of Treub (1898) and Lotsy (1899) describing the strange ovulate organ and apogamous embryo of species of Balanophora. Our knowledge of the group has now been extended by a paper just published by Dr. Lotsy,[16] in which he describes a species of

[11] SMITH, ROBERT: Botanical Survey of Scotland. I. Edinburgh District. II North Perthshire District. Scot. Geog. Mag. **16**: 385–416, 441–467. 1900.

[12] Bull. Soc. Bot. France **41**: 56–94. 1894. [13] Annales de Geographie. 1897.

[14] Nat. Sci. **14**: 109–120. 1899. [15] Scot. Geog. Mag. **16**: 597–599. 1900.

[16] LOTSY, J. P.: *Rhopalocnemis phalloides* Jungh., a morphological-systematical study. Ann. Jard. Bot. Buitenzorg II. **2**: 73–101. *pls. 3–14.* 1900.

Rhopalocnemis. The plant body is tuber-like, frequently as large as a man's head, is entirely devoid of even a trace of foliar organs, and is parasitic upon the roots of various trees. It seems to pass several years underground and comes to the surface but a short time before the development of flowers. The thick spicate flower clusters burst through the outer layers of the tuberous body, the individual flowers being well protected by peculiar peltate scales.

The carpellate flower consists of a syncarpous pistil, made up of two to five carpels, and inclosing a structure which Lotsy calls a free central placenta, and once, presumably by inadvertence, a nucellus. In any event, the structure is the enlarged tip of the axis of the flower, which soon completely fills the cavity of the ovary. At this stage one or more hypodermal cells of this axis tip enlarge, and without division are transformed into embryo sacs, one of which germinates in the usual way and passes through the ordinary ante-fertilization stages. The author regards this axial structure with its embryo sacs as a placenta without ovules; but, even aside from the fact that a placenta is nothing morphologically, the reviewer sees no reason for regarding the structure other than a terminal cauline ovule without integuments. A very large primary endosperm nucleus is formed in the usual way, but the author never observed a pollen tube, nor could he by repeated artificial pollination induce pollen tubes to develop. Under these circumstances Balanophora has learned to develop an embryo apogamously from the micropylar polar nucleus, but Rhopalocnemis is unable to do so, and hence has become practically a seedless plant. In just one case was Lotsy able to secure a few seeds, and even in them few stages of developing embryos were discovered, but enough to assure him that they had come from the egg, and probably a fertilized egg.

The staminate flowers are no less singular, each one consisting of a single structure which by courtesy may be called a stamen, but is probably a transformed axial structure. In its enlarged extremity numerous imbedded sporangia are developed, centrally as well as peripherally. These sporangia do not organize definite wall layers as in ordinary angiosperms, and have no method of dehiscence other than the breaking down of the superficial tissues. It would seem to be the rarest chance, therefore, if a pollen grain should ever reach a stigma, which in fact has usually lost all power of retaining pollen grains. The pollen grains are completely organized, and the two male cells appear, both of them finally assuming, along with the tube nucleus, an elongated, vermiform appearance, which according to Lotsy is merely preparatory to disorganization.

The twelve elaborate and handsomely colored plates present every detail observed, as well as the condition of the preparations. It is unfortunate that Dr. Lotsy writes in English, as his unfamiliarity with the language makes his

meaning a matter of inference rather than statement. While the well-informed English reader finally comes at his meaning, the paper must be baffling to the foreigner who is compelled to translate.—J. M. C.

PROFESSOR HARPER has given us a detailed description of the sexual reproduction of Pyronema.[17] The account is of especial interest, for it presents another instance of the fusion of multinucleate gametes, and is an important corroboration of Stevens' studies on *Albugo bliti* with respect to the behavior of cytoplasm and nuclei under such conditions.

The oogonium of Pyronema, as is well known, puts forth a conjugation tube (trichogyne) whose tip fuses with the antheridium. The tube is separated from the oogonium by a cross wall before its fusion, and this septum is later absorbed, when the protoplasm from the antheridium passes into oogonium and fertilizes the latter structure.

The oogonium and antheridium are multinucleate from the start. The conjugation tube likewise contains many nuclei, but these break down before fertilization. The number of nuclei in the oogonium is variable but there may be an many as two hundred. These gather in the central region of the structure, forming a closely packed collection at the time of fertilization. A great many sperm nuclei enter the oogonium through the conjugation tube, but they are hardly likely to equal the female nuclei in number. The sperm nuclei are attracted to the central mass of female nuclei, and shortly afterwards are found fusing in pairs with these elements. Some nuclei are always left over unmated, and these may be recognized for a long time by their smaller size. There is evidence that they finally break down.

The ascogenous hyphae spring directly from the fertilized oogonium, and as they develop the oogonium becomes rapidly emptied of its protoplasm and is finally left as a hollow cyst. The development of the asci is not essentially different from Peziza, Ascobolus, Erysiphe, and other types. The young ascus is the second cell of a curved branch. It contains two nuclei that fuse, and these are not sister nuclei. The fusion nucleus gives rise by successive mitoses to eight nuclei accompanied by the beautiful asters that Harper has described for several other forms, and the ascospores are cut out of the cytoplasm by these asters in the characteristic manner.

The ascocarp of Pyronema is a compound structure involving several systems of ascogenous hyphae from as many fertilized oogonia. The elements become so mixed that it is impossible to separate them. However, the ascogenous hyphae may be readily distinguished from the vegetative mycelium that forms the envelop of the ascocarp and the paraphyses in the hymenium. Harper points out that the characters most distinctive of the ascogenous hyphae are large nuclei, many times larger than those of the vegetative mycelium.

[17] HARPER, R. A.: Sexual reproduction in *Pyronema confluens* and the morphology of the ascocarp. Ann. of Bot. **14**: 321. *pls. 19–21.* 1900.

This study of Pyronema has important bearings in various directions and these are discussed at length. Along the lines of Harper's previous studies they serve to clinch more strongly his argument, supporting the views of De Bary, that the Ascomycetes have sexual organs. Indeed the opinions of Van Tieghem, Brefeld, and Dangeard seem to have passed below the horizon of the present day outlook, so conclusive is the evidence presented from work in various fields, among the lichens, the Laboulbeniales, the Perisporiales, and the Pezizales.

Pyronema is of especial interest because it presents characters somewhat intermediate between the simple fusion of the antheridium and oogoniun in Sphaerotheca, and the complex apparatus with the trichogyne found in the lichens and Laboulbeniales. Still it is very remarkable that such diverse conditions should appear in a single group, and the question seems very fair whether or not the Ascomycetes are a phylogenetic unit. However, the trend of investigation indicates complexities in life histories as well as structures among the fungi far greater than were at first imagined, and it is quite possible that widely different results may have quickly arisen under the pressure of peculiar life conditions.

The study of multinucleate gametes has opened an interesting line of investigation, and promises results that may materially modify our views of the evolution and differentiation of sexual organs among the Phycomycetes, and perhaps the Ascomycetes.— B. M. DAVIS.

IN A RECENT PAPER Wager gives an interesting account of his observations on *Euglena viridis* as they bear on the functions and relations of the eye spot and flagellum. After a brief résumé of the general morphology of the cell he takes up the vacuole system and gullet. He states definitely that, contrary to previous observations, the principal vacuole opens directly into the gullet, and therefore is an excretory reservoir. Just at this point Wager takes issue with the zoologists' claim of holozoic nutrition. Using powdered carmine in the culture medium he failed to find a single grain entering the gullet. He also brings forward tentatively Kawkine's explanation that the gullet is an absorptive region because paramylum grains are smallest in close proximity to it. Wager's views on the structure of the eye spot antagonize some older ideas and support others. In brief, the eye spot is composed of granules, bright red in color, imbedded in plasmatic network. The granules are in a single layer and with no regular arrangement. On treatment with alcohol, a reaction similar to that of disintegrating chlorophyll grains is obtained; hence the eye spot coloration is a derivative from chlorophyll. The origin of the spot *de novo* is in doubt. The flagellum and its close physical connection with the eye spot takes up the next paragraph. Nothing is known of its mechanism, however. Its structure is simple; a single filament with bifurcate base, bearing a swelling on one of the bifurcations. The

base is attached to the posterior side of the excretory reservoir. The swelling mentioned lies against and below the concave side of the eye spot. This fact leads to a consideration of the effect of light on Euglena. As is the case in all motile cells, strong light repels and a moderate light attracts. A bright light will cause the active cells to round up and encyst, if the stimulation be continued for several days. In darkness the cells round up, lose flagella, and divide. In spectrum rays, over seventy per cent. are drawn into the green-blue field. These blue rays are those absorbed by the red eye spot. As to the function of the eye spot, Wager makes two suggestions. First, that the absorbed blue rays stimulate the eye spot, which in turn stimulates the swelling on the flagellum; second, that by cutting off certain rays, the eye spot produces a definitely unequal illumination of the enlargement, and as a result, an attempt at orientation. Both hypotheses, however, he puts forward tentatively, subject to further and more careful investigation.—PHILIP G. WRIGHTSON.

R. A. ROBERTSON (Trans. and Proc. Bot. Soc. Edinburgh **21**: 290–298. *pls. 3*. 1900) has recorded and illustrated some interesting observations on variations in *Lycopodium clavatum*. A luxuriant patch of this plant growing in a wood became exposed by a great storm which removed nearly every tree, and upon 20 to 30 per cent. of the erect axes the observed variations were found. Of this varying material 87 per cent. had extra branching of the strobilus-bearing axes, 66 per cent. showed branching of the strobili, and in 9 per cent. the strobili were completely metamorphosed into leafy shoots. The author suggests that these variations are of interest in reference to the phylogeny of the Lycopodiales, the branching of the strobilus and the sterilization of sporogenous tissue being supposed to have played a part in the evolution of the group.—J. M. C.

THE LITERATURE of lenticels has been further supplemented by James A. Terras (Trans. and Proc. Bot. Soc. Edinburgh **21**: 341–352. *pls.* 2. 1900), who has written upon the relation between the lenticels and adventitious roots of *Solanum Dulcamara*. He concludes that these roots do not arise below or grow out through lenticels, as is apparently the case in the majority of plants, but that their origin is entirely independent of the formation of lenticels. Furthermore, he states that the protuberances on the surface of the stem are not lenticels, but result from the formation of a mass of secondary tissue which originates in the reaction of the phellogen to the pressure set up by the elongating root below it. The lenticels only appear after the protuberances are fully formed.—J. M. C.

NEWS.

THE *Fern Bulletin* for January contains an excellent portrait of Professor L. M. Underwood.

WE REGRET to learn of the death of Dr. S. J. Korshinsky, of St. Petersburg, at the age of 40. He had done some excellent work, especially in problems concerned with the vegetation of the steppes.

DR. M. RACIBORSKI, formerly professor of botany at the University of Cracow, and lately of Buitenzorg, has been appointed professor of botany and director of the botanical garden in the Dublany Agricultural Academy at Lemberg.

ONE GARDEN scholarship is to be awarded by Director Wm. Trelease, of the Missouri Botanical Garden, before April 1 next. Applications must be in his hands before March 1, and examinations will be held at the garden on March 5.

THE FRENCH ACADEMY OF SCIENCES has awarded the Desmazières prize to Abbé Hue for his "Mémoire sur une Classification des lichens fondée sur leur anatomie," and the Montaigne prize to M. J. Heribaud for his "Les Muscinées d'Auvergne."

THE VIENNA Academy of Sciences intends to send an expedition in 1901 to study the flora of Brazil. Professor Dr. Richard von Wettstein, director of the botanical garden of the University, and Dr. Victor Schiffner of Prague, will accompany the party.

THE BOTANICAL DEPARTMENT of the British Museum has purchased the Bescherelle herbarium of mosses and liverworts, the collection containing 14,800 specimens of the former, and 3500 of the latter. The herbarium is very rich in types and authentic specimens.

THROUGH the liberality of T. M. Baird, Jr., Esq., of Victoria, B. C., a tract of land on the coast of Vancouver island, opposite Cape Flattery, has been presented for a seaside botanical station of the University of Minnesota. The erection of a group of log buildings has been begun and a party of thirty or more botanists has been organized to open the work of the station next June.

AT A MEETING of the Botanical Section of the Philadelphia Academy of Natural Sciences, held December 10, 1900, the following officers were elected for the ensuing year: *Director*, THOMAS MEEHAN; *Vice director*, GEORGE M. BERINGER; *Treasurer* and *Conservator*, STEWARDSON BROWN; *Recorder*,

JOHN W. HARSHBERGER; *Executive Committee*, GEORGE M. BERINGER, THOMAS MEEHAN, STEWARDSON BROWN, JAMES D. CRAWFORD, IDA A. KELLER.

THE REPORT of the committee of the Society for Plant Morphology and Physiology on securing better reviews of botanical literature was presented at the recent meeting of the society at Baltimore. The results secured are of the greatest interest to all botanists. After correspondence with the editor and publisher of the *Botanisches Centralblatt*, a modification of this journal will be effected with the first number of the present year, and these changes are officially announced in the last number for 1900. Hereafter the *Centralblatt* proper will contain only reviews and the list of new literature, while the *Beihefte* will contain only original articles, and will appear as heretofore at irregular intervals. These may be subscribed for separately; the price and size of the former will remain as at present, *M* 28 per year. A committee of three from the society, Drs. Farlow, MacDougal, and Ganong, together with one botanist from the central states and one from the Pacific coast, to be named later, will be asked to nominate American editors, who will cooperate with the German editors, Drs. Uhlworm and Kohl. Inasmuch as the editors of the *Centralblatt* have shown themselves so willing to take up the suggestions made by this committee it should now be a matter of pride, and it certainly is a matter of self-interest as well, for American botanists to give the fullest support, financial and scientific, to this bibliographic journal. It should remain unique and become as perfect in its notices of literature as it is possible to make it. Separates, not titles merely, should still be sent to Dr. Uhlworm, Cassel.

THE following action was taken by the employés of the Department of Agriculture in reference to the death of Mr. Thomas A. Williams: It is with feelings of profound sorrow and regret that we, the employés of the Department of Agriculture, learn that death has removed from among us our beloved companion and coworker, Thomas A. Williams, a classmate and intimate associate of many of our number. His broad knowledge of scientific matters, his keen appreciation of nature, his kind and forbearing disposition have endeared him to all. He was known to his associates as an indefatigable worker and investigator.

Resolved, That in the death of Professor Thomas A. Williams, science and agriculture have suffered a great loss, and we, his associates, a dear friend, whose self-forgetfulness in his kindly consideration for the feelings of others and uniform cheerfulness, often under conditions of severe physical suffering, revealed a lovable character of the highest Christian type. The loss to the Division of Agrostology is irreparable. In the performance of his official duties he had proved himself an excellent executive and an organizer of unusual merit, and his relations with his associates in office were always such

as to command the highest esteem and respect. He never shirked a duty, and however difficult the undertaking the work performed by him was done most creditably. His loss will be felt most keenly by his associates in the division, and his memory will remain with them as one whose exemplary life and steadfastness of purpose they should strive to emulate.

Resolved, Further, that we tender to his bereaved family our heartfelt sympathy in their great loss and invoke for them the blessing of the Heavenly Father, who alone can heal the broken heart and give lasting comfort.

Resolved, That copies of these resolutions be sent to the family of the deceased and to the various daily and scientific journals.—Committee on Resolutions for the Department of Agriculture.

FROM ADVANCE sheets of the twelfth annual report of the director of the Missouri Botanical Garden we make the following extracts:

The garden has been maintained through the past year on about the same lines as for some years past. Though the revenue has not yet been increased through sales of real estate, the power to make such sales now makes it possible to spend on the garden the entire current revenue, which adds annually ten or fifteen thousand dollars to the available funds. The extensions which have been contemplated for some years past have now been begun. The improvements made this year consist in the grading of some twenty acres of land, and in planting the border about this tract. Two rather large ponds, connected by a meandering brook, were made, and the ground was given an easy fall from the streets to these bodies of water. All of the material used in this border plantation is representative of North American plants, and it is proposed to plant on this tract a collection of 181 arborescent, 269 fruticose, and some 1400 herbaceous species, representative of the North American flora, and arranged essentially in the familiar sequence of families of the "Genera Plantarum" of Bentham and Hooker. The garden now contains 9194 species and varieties of plants, of which 5547 are annuals or hardy perennials, and 3647 are cultivated under glass. A further extension of the plant houses has been made by the erection of a tower at the northwestern corner of the system, in which small but representative collections of succulents and of acacias and acacia-like plants have been planted out in a natural manner. The material incorporated in the herbarium during the year comprises 8415 sheets of specimens. The additions to the library in 1900 include 573 books and 31 pamphlets purchased, and 311 books and 456 pamphlets presented or sent in exchange for garden publications. Of serial publications the garden now receives 1117, all but 66 by exchange. The garden has materially assisted the botanical work in the public schools by supplying material. Several pieces of research work are about ready for publication.